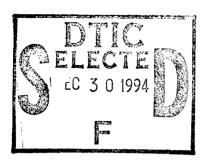
# IMPROVED HARDNESS RHA WELDABILITY AND MATERIAL PROPERTY TESTING



### **TECHNICAL REPORT**

DOCUMENT TITLE

FINAL

DECEMBER 1994

PREPARED UNDER CONTRACT NUMBER
DAAL04-91-C-0040

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GENERAL DYNAMICS

Land Systems Division

P.O. Box 2074, Warren, Michigan 48090-2074

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testing, stud welding and maximur	n heat input testing. The ma	achinability testing i	nvolved machining	g parts in	cluding drilling, tapping,
reaming, boring and milling. Plasr vehicle fabrication. The ballistic te	na and Oxy-fuel thermal cut	ting were studied to	gauge processing	g of the s	teel by present armor
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# IMPROVED HARDNESS RHA MATERIAL EVALUATION CONTRACT NO. DAAL04-91-C-0040

### 1.0 INTRODUCTION

This final report prepared by General Dynamics Land Systems (GDLS) for the U.S. Army Research Technology Laboratory documents results of the series of weldability and material property evaluation tests performed by GDLS on the improved hardness rolled homogeneous armor (RHA) steel provided by the U.S. Army Research Laboratory. The work was performed pursuant to Statement of Work (SOW) included in the Request for Proposal (RFP) under Contract DAAL04-91-C-0040.

#### 2.0 OBJECTIVE

The primary objective was to evaluate the weldability and material properties of the improved hardness rolled homogeneous armor (RHA) steel supplied by U.S. Army Research Laboratory (ARL). The U.S. ARL is investigating the potential of up-armoring the M1 family of vehicles by increasing the hardness of rolled homogeneous armor (RHA) MIL-A-12560 steel. The changes required in the chemical composition and heat treatments are not expected to cause any revisions to the current specification for MIL-A-12560 steel. The increased hardness levels may provide increased ballistic protection against large caliber kinetic energy threats. The hardness level of the steel supplied by U.S. ARL was to have a through thickness hardness of RC 39-48.

#### 3.0 CONCLUSIONS

The material properties results of the improved hardness RHA steel met all the minimum requirements of the current MIL-A-12560 specifications. Although the material hardenability of the steel was higher than the normal RHA steel, the plate cutting operation using today's thermal cutting processes (oxy-fuel and plasma) were successful with no edge defects. Slightly lower cutting speeds had

to be used to maintain a consistent cutting edge with the improved hardness RHA steel.

Although the weldability testing (Y-groove) was performed on the Jessop steel prior to the shipment of the improved hardness steel (U.S. Steel chemistry), an increased preheat temperature was determined to be required during welding of the steel to prevent cracking. It was mutually agreed between GDLS and the Army Research Laboratory that a minimum preheat and interpass temperature of 300° F. would be maintained during welding. The ballistic H-plates were successfully fabricated at GDLS using three different weld processes. The ballistic testing of the H-plates performed by the Combat Systems Test Activity (CSTA) met the minimum requirements of CSTA TOP-211-711 "Ballistic Testing of the Armor Weldments."

The machinability testing on various parts made from the improved hardness RHA was deemed successful. All machining was done using the current tooling and parameters used to machine RHA on today's Abrams vehicles. The tool life may be reduced slightly due to the increased hardness.

#### 4.0 RECOMMENDATIONS

All phases of this effort indicated that IRHA material, as tested, was amenable to processing by methods presently employed for manufacturing the Abrams vehicle at LATP. All cutting, welding and machining practices were successful with some minor adjustments for the material hardness. However, the scope of this evaluation did not allow for the definition of the most optimum processes.

Further investigation is necessary to determine the actual preheat requirements which will be inherent to welding the improved hardness RHA steel by plate thickness. Additional H-plate testing should be performed to qualify additional weld processes. Additional machinability testing would be required to obtain ideal tooling parameters and tool alloys to machine the improved hardness RHA steel.

#### 5.0 DISCUSSION

# 5.1 <u>Material Property Evaluation</u>

Base plate Charpy V-notch (CVN) tests were performed on each thickness (1.25" and 1.50") of material supplied by the U.S. Army Research Laboratory. Seven (7) tests were performed on each thickness. All base metal plate CVN tests met the minimum requirement of MIL-A-12560 material. The results are shown in Attachment 1.

One welded mechanical property test plate was fabricated using two (2) 6"x12"x1.25" plates butt welded together using the high current density (HCD) weld process. Ten (10) CVN tests were performed in the heat affected zone (HAZ) of the welded plate. The weld parameters and test results are shown in Attachment 1.

All CVN tests were performed according to ASTM E23 and A370 at a temperature of -40° F. All specimens were taken transverse to the rolling direction and conducted in the T-L orientation at the plate centerline. The butt welded test specimens were notched in the heat affected zone.

Standard tensile tests were performed on each thickness (1.25" and 1.50") to determine the ultimate tensile strength (UTS), and 0.20% offset yield point, percent reduction in area, and percent elongation of the base material. All tests were performed per ASTM E8 at ambient temperature (70° F.) in both the transverse and longitudinal orientations. Duplicate tests were taken at both orientations. The test results are shown in Attachment 1.

Brinell hardness tests were taken on the top and bottom plate surfaces of each thickness (1.25" and 1.50"). Duplicate Brinell hardness readings were also taken on each Charpy bar specimen. A through thickness Rockwell "C" traverse was performed on a plate of each thickness (1.25" and 1.50"). All hardness tests were performed per ASTM E10 and E18. The hardness test results are shown in Attachment 1.

Triplicate bend tests were performed on the 1.50" thick material. The specimens were 3/8" thick across the 1.50" dimension and were 12" in length taken from the plate centerline. The three (3) specimens were bent 180° over a 1.50" diameter pin. The tests were performed in accordance with ASTM E290 by Bowser-Morner, Inc., (BMI No. 94040068). All three (3) specimens showed some small cracking. The crack lengths were 0.05" or less.

Stress corrosion tests were performed on each thickness (1.25" and 1.50") to determine the susceptibility of the material to stress corrosion cracking (SCC) following production thermal processing. Six (6) plates 6"x12" were cut from each thickness by under water plasma units and exposed to a salt fog spray. The plates were periodically monitored to determine if any edge defects/cracks associated with thermal cutting propagate out of the edge heat affected zone. The plate edges were AC and DC magnetic particle inspected as well as dye penetrant inspected prior to and after the salt fog spray operation. There were no defects/cracks observed at any time. The salt fog spray booth was maintained as required per MIL-STD-117. The test data is shown in Attachment 2.

Three (3) Jominy (1.00" diameter) bars were machined and end quench tested per ASTM-A-255 (89). The Jominy End Quench Test was performed to determine the material hardenability and the respective critical diameter (DI). The Mini-Tech hardenability computer model was also run for the material composition and is shown in Attachment 3.

The complete chemical composition present in the steel was performed in accordance with ASTM E350 and E1019. The level of hydrogen, nitrogen, and oxygen was also determined. The tests were performed on the 1.50" thick plate and the results are shown in Attachment 4.

The microstructure of each thickness (1.25" and 1.50") was examined using standard metallographic practices to determine the microstructure at the centerline, surface, and 1/4 thickness. The specimens were prepared and macro-etched to determine the material structure, grain size, inclusion content morphology and to

quantify the amount of retained Austenite present in the steel. The test results are shown in Attachment 4.

# 5.2 Weldability and Thermal Cutting

Plasma cut and oxy-fuel programs were developed to cut ten (10) 6"x12" test blanks from each plate thickness (1.25" and 1.50") to define processing ability with present RHA armor vehicle fabrication methods. Macro- and microscopic metallographic evaluations and scanning electronic microscope (SEM) evaluations were performed to define the condition of the cut edge. Magnetic particle (AC and DC) and dye penetrant nondestructive tests (NDT) were performed to assess the internal soundness of the cut edge. No defects or indications were observed during the NDT tests. The results of the evaluations are shown in Attachment 5. It should be noted that slightly slower travel speeds had to be used to maintain a consistent cut edge. It was more prominent during oxy-fuel cutting as compared to the plasma cut process. The extra thick mill scale on the plate surface is believed to be the problem.

A weldability evaluation was conducted using the Y-groove method as adapted by GDLS. The evaluation was performed on the Jessop #1 and Jessop #2 steel supplied by the Army Research Laboratory prior to arrival of the improved hardness RHA steel. Evaluation was conducted on 1.50" and 2.50" thick Jessop #1 material and 1.25" thick Jessop #2 material. Preheat temperatures used on the Jessop #1 material were 300 and 400 degree F. Preheat temperatures of 200, 250, 275 and 300 degree F. were used on the Jessop #2 material. Test weld joints were flame cut and ground prepped to final configuration. Preheating was conducted using a gas rosebud torch and verified using a contact pyrometer. The material provided was sufficient to run only five tests of each thickness. The joint set-up is shown in Attachment 6.

Initially two tests were run with each thickness of Jessop #1 steel; two were run at each of the preheat levels of 300 and 400 degrees F. After a 72 hour incubation period, the weld joint was removed by flame cutting and the edges ground. The test coupons were sectioned, metallographically prepared for microscopic examination. No heat affected zone (HAZ) cracking occurred on these sections.

Data sheets 1 through 4 are enclosed in Attachment 6. A second set of tests were run on the Jessop #1 material with revised parameters. Three tests were run for each thickness. The wire speed was reduced from 375 IPM to 315 IPM in an effort to reduce penetration slightly and maintain a more desirable weld bead configuration. The second set of tests yielded no HAZ cracking. Data sheets 5 through 10 are enclosed in Attachment 6.

Five (5) tests were run at each preheat temperature on the Jessop #2 material. HAZ cracking was exhibited on four of the five samples preheated at 200° F. and one of the five samples at 250° F. No HAZ cracking was exhibited in either the 275 or the 300 degree F. tests. Data sheets 12 through 31 are shown in Attachment 6.

These initial tests indicate the Jessop #1 material is weldable under certain conditions. However, the limited number of tests yields inconclusive results. Similar testing conducted at ARL resulted in HAZ cracking. The only notable difference in the testing schemes being that the ARL test plates were machined to configuration and not flame cut.

The tests performed on the Jessop #2 material indicate an increase in the preheat temperature would be required compared to our present RHA armor to reduce the chance of cracking. Further investigation is necessary to determine the actual preheat requirements by plate thickness.

One (1) stud weld qualification plate was fabricated in accordance with MIL-STD-248. The 24"x24"x1.50" plate was plasma cut and shot blast to clean the plate surface. It was noted that not all of the hard mill scale was removed from the plate surface. Sixty (60) studs (fifteen (15) of four (4) sizes) were stud welded to the plate surface using GDLS approved welding procedure. Each stud was "bend" tested in accordance with MIL-STD-248. Ten (10) studs of each size were removed by grinding and the plate surface was dye penetrant inspected. Metallographic (cross section) evaluation was performed on one (1) stud of each size. All tests met the requirements of MIL-STD-248 with no weld failures recorded. The data sheets and photographs are enclosed in Attachment 7.

# 5.3 H-Plate Fabrication and Ballistic Testing

Three (3) H-plates were fabricated using the 1.50" thick improved hardness RHA steel, and one (1) H-plate was fabricated using the current 1.50" thick RHA steel used in armor tank fabrication. Three (3) different approved welding processes were used to fabricate the improved hardness H-plates.

H-plate	106	High current density (HCD)
H-plate	107	GMAW spray transfer
H-plate	108	GMAW pulsed spray transfer

The RHA H-plate (H-plate 74) was welded using the high current density welding process with the same parameters as H-plate 106. The three (3) improved hardness RHA H-plates were fabricated maintaining a 300° F. preheat and interpass temperature while the RHA H-plate maintained a 200° F. preheat and interpass temperature. The four (4) H-plates were X-ray examined to ASTM E390 Grade 2 and shipped to U.S. Army Combat System Test Activity in Aberdeen, Maryland, for ballistic testing using a 75 mm plate proof projectile. The ballistic testing met the minimum ballistic requirements. The H-plate data sheets and firing records are enclosed in Attachment 8.

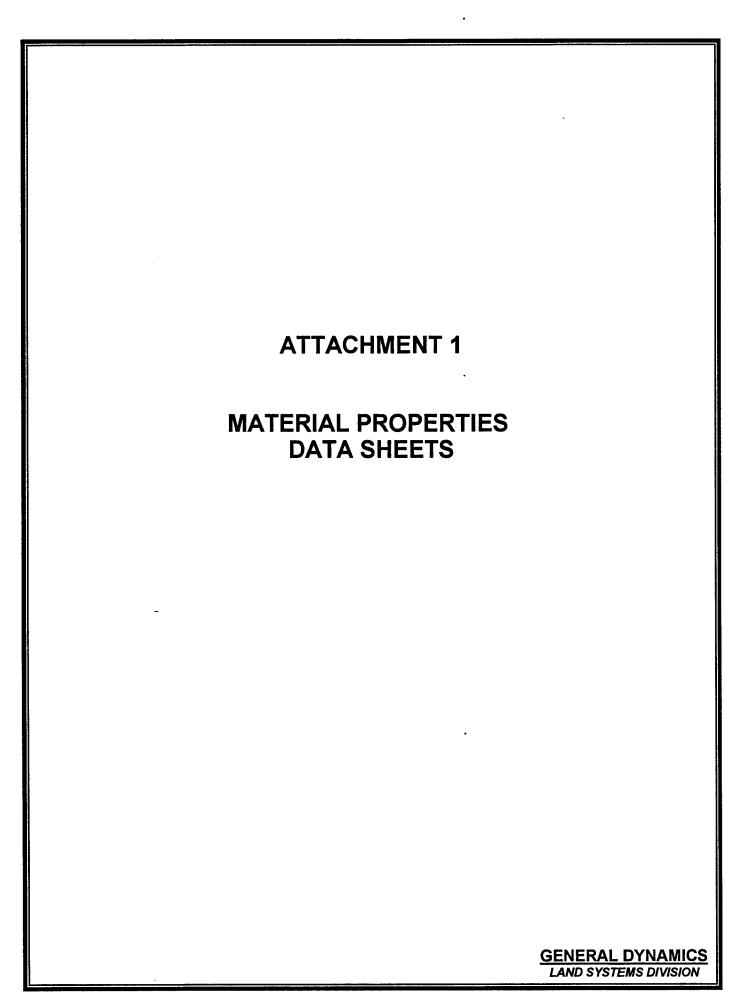
# 5.4 <u>Machinability Testing</u>

CNC programs were developed to machine components from the improved hardness RHA steel to evaluate tool life and performance, stress relieving, material work hardening and coolant performance and effect. The machined components included milling, drilling, tapping, boring and reaming operations.

Six (6) ammo door support (P/N 9377636-1 MD) plates were machined from the 1.50" thick material. The machining consisted of edge milling two (2) sides, drill and tapping four (4) 1/4-20 UNC-2B holes and two (2) 3/8-16 UNC-2B holes on each plate. The same tooling and parameters were used as on today's RHA steel. All the machining operations performed satisfactory. During the drilling of the 1/4-20 UNC-2B holes, the drills began "dulling" considerably faster on the improved RHA steel as compared to the RHA steel plates. This problem could be resolved by varying the tooling and/or

the feed parameters. The part configuration and the data sheets are enclosed in Attachment 9.

Three (3) blow-off panel (P/N 12931206-1 MD) plates were machined from the 1.25" thick material. The machining consisted of face milling the plate surfaces, drill and tapping five (5) .625-11 UNC-2B holes, end milling a .55" width seal groove, drill and ream six (6) .3937 holes, drilling eight (8) .430" holes and end milling three (3) 2.750" holes on each plate. The same tooling and parameters were used as on today's RHA material. All of the machining operations performed satisfactory with no notable difference from the machining on RHA material. It should be noted that during the surface face milling, large chips (approximately .38" diameter) were noted on several inserts. The cutting edges of the insert did not wear excessive and the plate cutting surface was acceptable. The large chips could be occurring due to the hard mill scale noted on the plate surfaces. The plates were shot blast but large amounts of mill scale remained on the plate surface. The plate surfaces remained relatively flat (W/I .06") after approximately .25" material was face milled away. This stress relief characteristic of the improved hardness material showed better than the today's RHA material. part configuration and data sheets are enclosed in Attachment 9.



### **CVN TEST RESULTS**

# BASE PLATE CHARPY V-NOTCH (CVN) TEST RESULTS:

# **BREAKING ENERGY IN FT-LBS**

SPECIMEN NO:	<u>1.25" PLATE</u>	<u>1.50" PLATE</u>
1	21.5	16.5
2	24.5	20.0
3	26.5	19.0
4	23.0	20.0
5	22.5	17.0
6	25.5	20.5
7	22.0	18.0
Average:	23.6	18.7

# **BUTT WELDED HAZ CHARPY V-NOTCH (CVN) TEST RESULTS:**

#### **BREAKING ENERGY IN FT-LBS**

SPECIMEN NO:	BUTT WELDED 1.25" PLATE
1	21.5
2	65.5
_ 3	70.0
4	75.5
5	66.0
6	109.0
7	71.0
8	64.0
9	64.0
10	62.0
Average:	71.8

NOTES: TESTS PERFORMED IN ACCORDANCE WITH ASTM E23.

TESTS PERFORMED AT -40°F.

SPECIMENS WERE TAKEN TRANSVERSE TO THE ROLLING DIRECTION AT THE

PLATE CENTER LINE.

BUTT WELDED TEST SPECIMENS WERE NOTCHED IN THE HEAT AFFECTED ZONE.

TESTS WERE PERFORMED BY BOWSER-MORNER, INC (BMI NO. 94040068)

# **BASE PLATE TENSILE TEST RESULTS**

SPECIMEN NO: Test Direction	1.25" PL Longitud		<u>1.50" P</u> Longitu	
Specimen	Α	В	Α	В
Dimension, inches Area, Square inches Tensile Strength, psi 0.2% Offset Yield Strength % Elongation in 2.0" Reduction of Area, %	0.499 0.1956 185,500 165,600 13.0 51.4	0.502 0.1979 186,000 164,700 14.0 52.5	0.501 0.1971 189,800 169,000 14.5 53.1	0.502 0.1979 189,100 168,300 15.0 56.8

SPECIMEN NO: Test Direction	1.25" PL Longitud		<u>1.50" P</u> Longitu	
Specimen	Α	В	Α	В
Dimension, inches Area, Square inches Tensile Strength, psi 0.2% Offset Yield Strength % Elongation in 2.0" Reduction of Area, %	0.499 0.1956 185,700 165,600 12.5 45.6	0.502 0.1979 184,500 164,700 12.5 48.0	0.505 0.2003 188,700 167,800 13.0 47.2	0.497 0.1940 189,700 169,100 12.0 45.8

NOTES: TESTS PERFORMED IN ACCORDANCE WITH ASTM E8

TESTS PERFORMED AT 70°F.

SPECIMENS WERE MACHINED AT THE BASE PLATE CENTERLINE

TESTS WERE PERFORMED BY BOWSER-MORNER, INC (BMI NO. 94040068)

#### HARDNESS TEST RESULTS

# BRINELL SURFACE HARDNESS DATA

Performed in accordance with ASTM E10

Location:	1.25" Plate	1.50" Plate
Тор	363	375
Bottom	375	388

Note: Tests performed using a 10-mm ball employing a 3000 Kg load

# ROCKWELL 'C' HARDNESS DATA ON CVN SPECIMENS Performed in accordance with ASTM E18

#### **BASE PLATE SPECIMENS**

Specimen No:	<u>1.25"</u>	<u>Plate</u>	<u>1.50"</u>	Plate
	Α	В	Α	В
1	39.2	38.9	40.7	40.5
2	34.0	36.7	38.9	37.5
3	36.9	35.4	39.4	37.8
4	37.5	37.2	39.0	38.3
5	36.0	34.9	38.6	37.8
6	38.6	37.4	39.2	39.0
7	38.8	37.1	38.7	37.8

# **BUTT WELDED HAZ SPECIMENS**

Specimen No:	Weld	Base Metal
1	13.9	37.5
2	13.0	39.0
3	12.9	39.0
4	13.7	39.3
5	17.5	39.1
6	22.0	38.8
7	16.0	39.0
8	15.0	37.6
9	10.0	38.9
10	13.9	37.9

Note: Weld metal hardness should have been reported in the Rockwell 'B' scale.

We reported in the Rockwell 'C' scale as a better comparison of the

two (2) hardness areas.

Tests were performed by Bowser-Morner, INC (BMI No. 94040068)

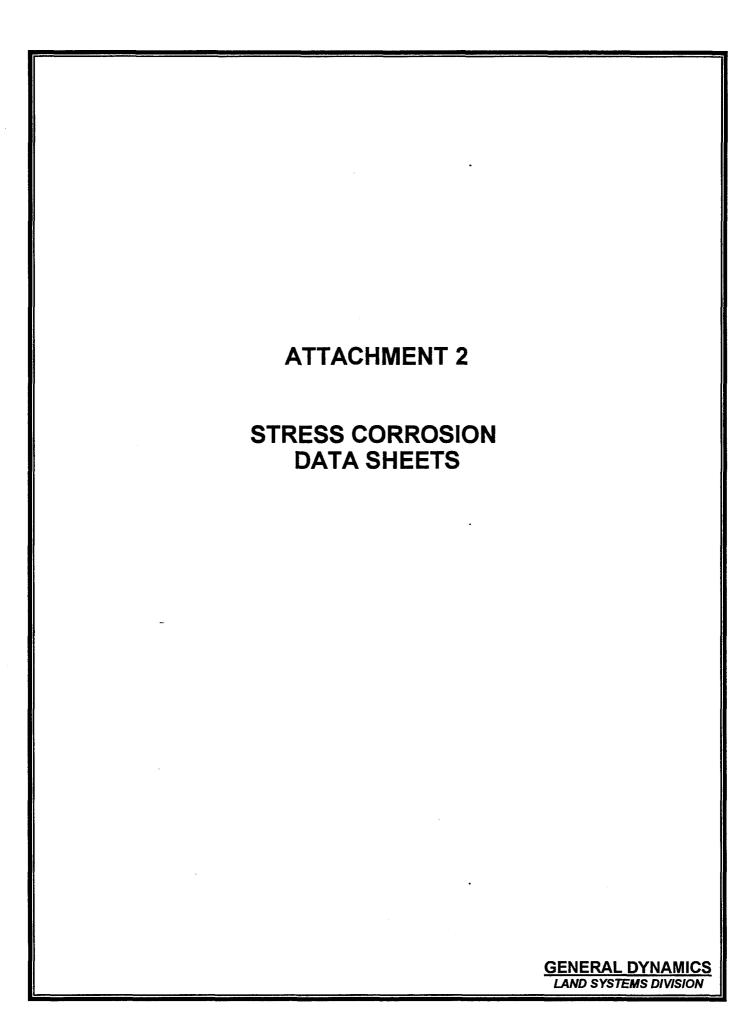
# **HARDNESS TEST RESULTS (cont.)**

# ROCKWELL 'C' THROUGH HARDNESS DATA Performed in accordance with ASTM E18

### **BASE PLATE SPECIMENS**

<u>Lc</u>	cation:	<u>1.25" Plate</u>	1.50" Plate
Тор-	1	39.2	39.0
	2	40.2	40.0
	3	40.5	40.2
	4	40.8	40.2
Center	5	39.0	41.3
	6	39.5	40.0
	7	40.3	40.7
	8	39.0	40.8
	9	39.4	38.4
<b>Bottom</b>	10	38.4	40.0

**Note:** Hardness readings were evenly spaced across the plate thickness. Tests were performed by Bowser-Morner, INC (BMI No. 94040068)



# **I-RHA STRESS CORROSION DATA SHEET**

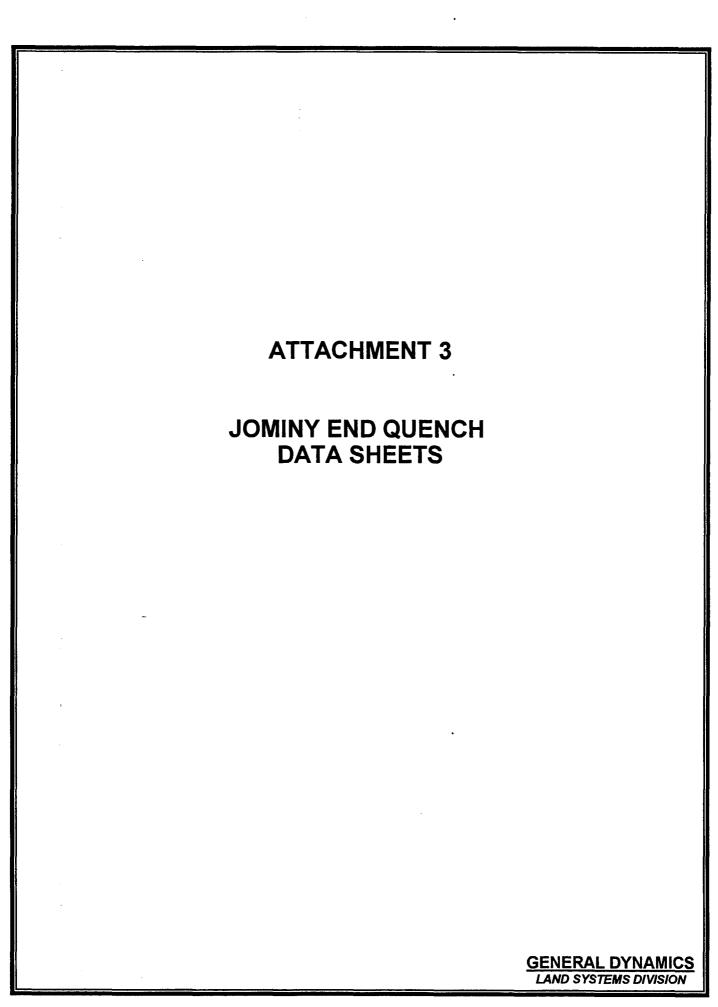
PLATE I.D.	PLATE THICKNESS	DATE STARTED	1ST CHECK	2ND CHECK	3RD CHECK	RESULTS	TOTAL HOURS
IRHA-A	1.25"	JAN.28	FEB. 14	FEB.28		NO CRACKS	650
IRHA-B	1.25"	JAN. 28	FEB. 14	FEB. 28	*******	NO CRACKS	650
IRHA-C	1.25"	JAN.28	FEB. 14	FEB. 28		NO CRACKS	650
IRHA-D	1.25"	JAN. 28	FEB. 14	FEB.28	MARCH 21	NO CRACKS	1050
IRHA-E	1.25"	FEB. 28	MARCH 21			NO CRACKS	500
IRHA-F	1.25"	FEB. 28	MARCH 21			NO CRACKS	500
IRHA-G	1.50"	JAN. 28	FEB. 14	FEB. 28	MARCH 21	NO CRACKS	1050
IRHA-H	1.50"	JAN. 28	FEB. 14	FEB. 28	**********	NO CRACKS	650
IRHA-I	1.50"	JAN.28	FEB. 14	FEB. 28		NO CRACKS	650
IRHA-J	1.50"	FEB. 28	MARCH 21			NO CRACKS	500
IRHA-K	1.50"	FEB. 28	MARCH 21			NO CRACKS	500
IRHA-L	1.50"	FEB.28	MARCH 21		*********	NO CRACKS	500

NOTES:

-Salt fog spray booth maintained per MIL-STD-117

<sup>-</sup>The number of plates which could be inserted at one time was limited due to the size of the salt fog spray booth

<sup>-</sup>The edges were AC and DC Magnetic Particle and Dye Penetrant inspected for indications/ cracks prior to salt spray test, at checkpoints and after test

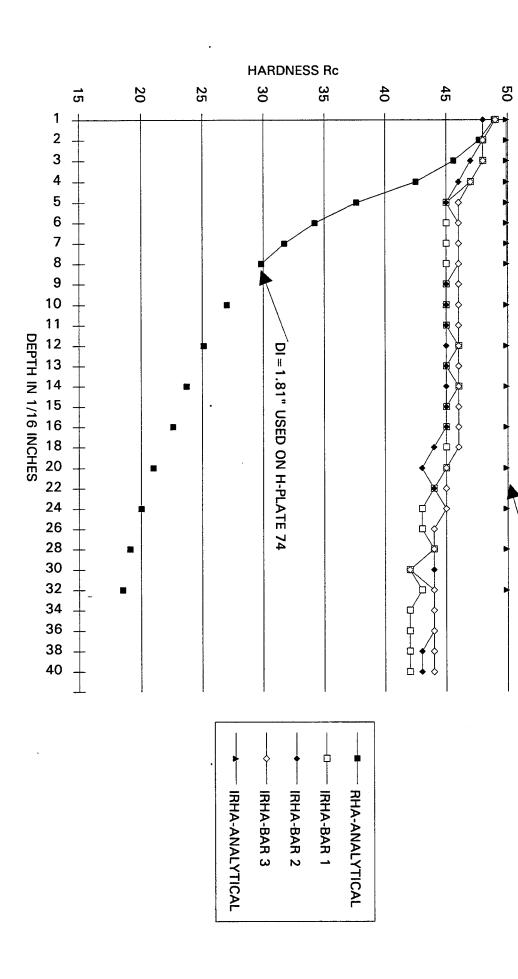


# ATTACHMENT 3 JOMINY END QUENCH DATA SHEET

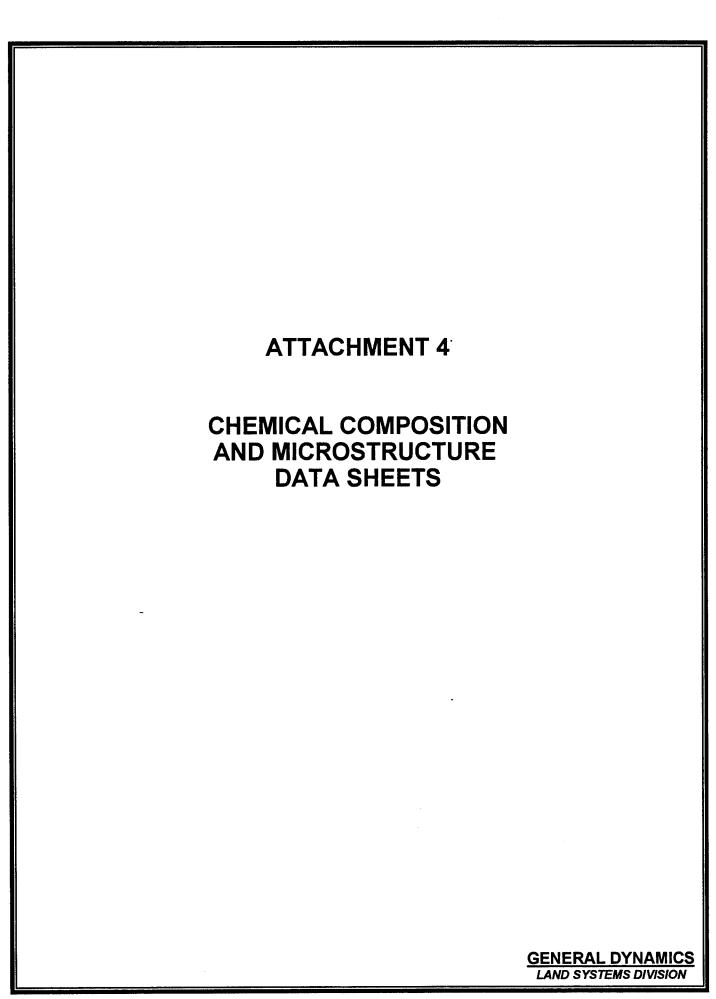
DEPTH	RHA-ANAL.	IRHA-BAR1	IRHA-BAR2	IRHA-BAR3	IRHA-ANAL
1/16 INCHES	Rc	Rc	Rc	Rc	Rc
1	48.9	49	48	49	49.9
2	47.7	48	48	48	49.9
3	45.6	48	47	48	49.9
4	42.5	47	46	47	49.9
5	37.6	45	45	46	49.9
6	34.2	45	46	46	49.9
7	31.7	45	46	46	49.9
8	29.8	45	46	46	49.9
9		45	45	46	
10	27	45	45	46	49.9
11		45	45	46	
12	25.1	46	45	46	49.9
13		45	45	46	
14	23.7	46	45	46	49.9
15		45	45	46	
16	22.6	45	45	46	49.9
18		45	44	46	
20	21	45	43	45	49.9
22		44	44	45	
24	20	43	45	45	49.9
26		43	44	44	
28	19.1	44	44	44	49.9
30		42	44	42	
32	18.5	43	44	44	49.9
34		42	44	44	
36		42	44	44	
38		42	43	44	
40		42	43	44	

**JOMINY END QUENCH DATA SHEET** 

DI = 6.96"



GENERAL DYNAMICS LAND SYSTEMS DIVISION



# CHEMICAL COMPOSITION AND MICROSTRUCTURE

# **CHEMICAL COMPOSITION**

Performed in accordance with ASTM E350 and E1019

COMPOSITION	<b>CONTENT</b>	PROPOSED Ni-Cr-Mo
Carbon, %	0.27	.2628
Manganese, %	0.39	0.80
Sulfur, %	0.005	0.005
Phosphorous, %	0.008	0.010 <b>Ma</b> x.
Nickel, %	3.27	2.6 <b>M</b> in.
Chromium, %	1.49	0.80
Molybdenum, %	0.57	0.50
Silicon, %	0.35	0.30
Nitrogen, %	0.061	
Oxygen, %	0.096	
Hydrogen, %	0.023	

NOTE: The Metallurgical Test Report supplied by U. S. Steel delivered to GDLS with the steel shipment is attached to the report in Attachment 4. Test performed by Bowser-Morner, INC (BMI No. 94040068)

### **MICROSTRUCTURE EXAMINATION**

PLATE SIZ	<u>LOCATION:</u>	MICROSTRUCTURE		
1.25"	Surface	Tempered Martensite with a surface layer 0.05" thick that appears to be a lower Carbon Martensite than in the body of the plate material. There is an oxide or mill scale 0.002" to 0.004" thick. See Photo 1.		
1.25"	0.3125" (1/4 thickness)	Tempered Martensite, See Photo 2.		
1.25"	0.625" (1/2 thickness)	Tempered Martensite, See Photo 3.		
1.50"	Surface	Tempered Martensite with a surface layer 0.02" thick that appears to be a lower Carbon Martensite than in the body of the plate material. There is an oxide or mill scale 0.002" to 0.0044" thick. See Photo 4.		
1.50"	0.375" (1/4 thickness)	Tempered Martensite, See Photo 5.		
1.50"	0.750" (1/2 thickness)	Tempered Martensite, See Photo 6.		
	Tests performed by Bows BMI No. 94040068)	er-Morner, INC  GENERAL DYNAMICS  LAND SYSTEMS DIVISION		

# **CHEMICAL COMPOSITION AND MICROSTRUCTURE (cont.)**

### **GRAIN SIZE**

Grain size determined according to ASTM E112 comparison to plate I.

1.25" Plate

1.50" Plate

**ASTM Grain Size** 

8.0

8.0

See Photos 7 and 8

### **INCLUSION CONTENT**

Inclusion content was determined according to ASTM E45 comparison to plate I.

1.25" Plate

1.50" Plate

Type

**D-Globular Oxides** 

**D-Globular Oxides** 

Series

Heavy

Thin

Rating, Number

1.5

1.5

See Photos 9 and 10

### **RETAINED AUSTENITE**

Performed by X-ray Diffraction Spectroscopy in accordance with ASTM E975.

1.25" Plate

1.50" Plate

Austenite, %

Not Detected<3 Not Detected<3

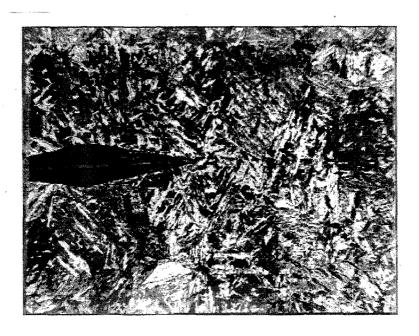
**NOTE:** Tests performed by Bowser-Morner, INC (BMI No. 94040068)

Photo I



Near-Surface Micrograph 1.25" Plate 500x Magnification Vilella's Reagent Etch

Photo II



1/4 Thickness (0.3125") Micrograph 1.25" Plate 500x Magnification Vilella's Etch

Photo III



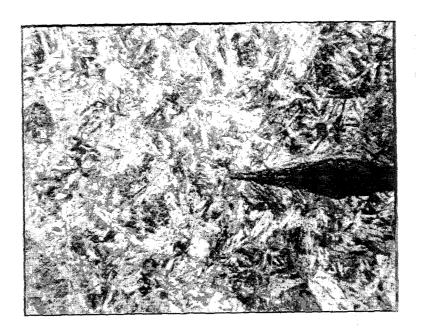
Thickness Center (0.625") Micrograph 1.25" Plate 500x Magnification Vilella's Etch

Photo IV



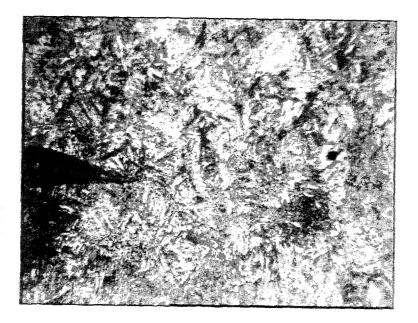
Near Surface Micrograph 1.50" Plate 500x Magnification Vilella's Etch

# Photo V



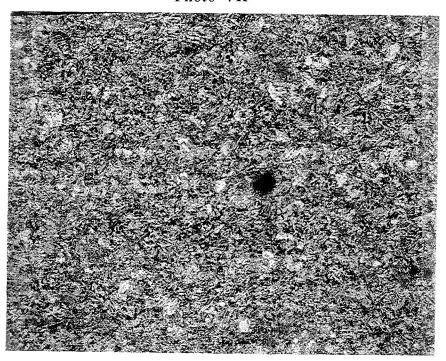
1/4 Thickness (0.375")Micrograph 1.50" Plate 500x Magnification Vilella's Etch

Photo VI



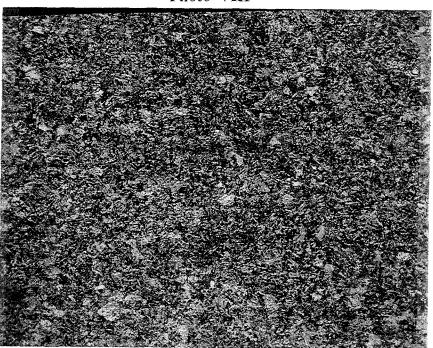
Thickness Center (0.750") Micrograph 1.50" Plate 500x Magnification Vilella's Etch

# Photo VII



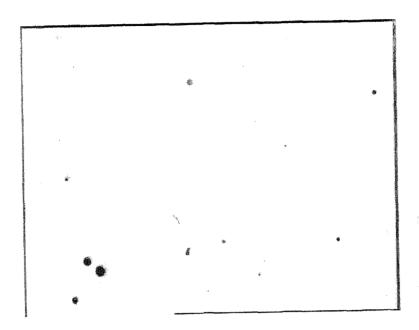
Grain Size Micrograph 1.25" Plate ASTM 8.0 100x Magnification Vilella's Etch

### Photo VIII



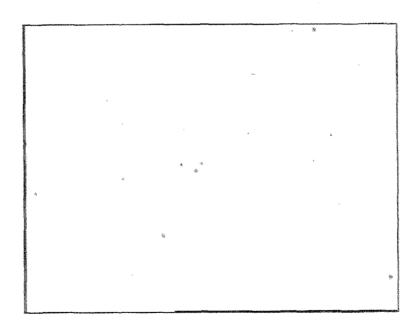
Grain Size Micrograph 1.50" Plate, ASTM 8.0 100x Magnification Vilella's Etch

### Photo IX



Inclusion Content 1.25" Plate, 1.5 Heavy Type "D" Globular Oxides 100x Magnification Unetched

# Photo X



Inclusion Content 1.50" Plate, 1.5 Thin Type "D" Globular Oxides 100x Magnification Unetched

**ATTACHMENT 5 PLATE CUTTING DATA SHEETS GENERAL DYNAMICS** LAND SYSTEMS DIVISION

# **PLATE CUTTING DATA SHEET**

PLATE SIZE 12" X 6" X 1.25"	DATE DECEMBER 14, 1993
PLATE NUMBER HEAT T43401	PERFORMED BY MARK NIESE

	<b>OXY-FUEL CUT</b>	
MT (AC)	MT (DC)	PT
<ol> <li>NO INDICATIONS</li> </ol>	<ol> <li>NO INDICATIONS</li> </ol>	<ol> <li>NO INDICATIONS</li> </ol>
7. NO INDICATIONS 8. NO INDICATIONS 9. NO INDICATIONS 10.NO INDICATIONS	7. NO INDICATIONS 8. NO INDICATIONS 9. NO INDICATIONS 10. NO INDICATIONS	7. NO INDICATIONS 8. NO INDICATIONS 9. NO INDICATIONS 10.NO INDICATIONS
	PLASMA CUT	
MT (AC)	MT (DC)	PT
<ol> <li>NO INDICATIONS</li> </ol>	<ol> <li>NO INDICATIONS</li> </ol>	<ol> <li>NO INDICATIONS</li> </ol>

# PLATE CUTTING DATA SHEET

PLATE SIZE 12" X 6" X 1.50"
PLATE NUMBER HEAT T43401

DATE DECEMBER 15, 1993
PERFORMED BY MARK NIESE

#### **OXY-FUEL CUT** PT MT (DC) MT (AC) 1. NO INDICATIONS 1. NO INDICATIONS 1. NO INDICATIONS 2. NO INDICATIONS 2. NO INDICATIONS 2. NO INDICATIONS 3. NO INDICATIONS 3. NO INDICATIONS 3. NO INDICATIONS 4. NO INDICATIONS 4. NO INDICATIONS 4. NO INDICATIONS 5. NO INDICATIONS 5. NO INDICATIONS 5. NO INDICATIONS 6. NO INDICATIONS 6. NO INDICATIONS 6. NO INDICATIONS 7. NO INDICATIONS 7. NO INDICATIONS 7. NO INDICATIONS 8. NO INDICATIONS 8. NO INDICATIONS 8. NO INDICATIONS 9. NO INDICATIONS 9. NO INDICATIONS 9. NO INDICATIONS 10.NO INDICATIONS 10. NO INDICATIONS 10.NO INDICATIONS

# PLASMA CUT

MT (AC)	MT (DC)	PT	
1. NO INDICATIONS	1. NO INDICATIONS	1. NO INDICATIONS	
2. NO INDICATIONS	2. NO INDICATIONS	2. NO INDICATIONS	
3. NO INDICATIONS	3. NO INDICATIONS	3. NO INDICATIONS	
4. NO INDICATIONS	4. NO INDICATIONS	4. NO INDICATIONS	
5. NO INDICATIONS	5. NO INDICATIONS	5. NO INDICATIONS	
6. NO INDICATIONS	6. NO INDICATIONS	6. NO INDICATIONS	
7. NO INDICATIONS	7. NO INDICATIONS	7. NO INDICATIONS	
8. NO INDICATIONS	8. NO INDICATIONS	8. NO INDICATIONS	
9. NO INDICATIONS	9. NO INDICATIONS	9. NO INDICATIONS	
10.NO INDICATIONS	10. NO INDICATIONS	10.NO INDICATIONS	

# PLATE CUTTING DATA SHEET

#### HARDNESS TRAVERSE READINGS

<b>OXY-FUEL CUT</b>			PLASMA CUT	
1.25"	1.50"	<b>THICKNESS</b>	1.25"	1.50"
		DISTANCE FROM CUT EL	OGE	
RC 54	RC 53	.03"	<b>RC 48</b>	RC 49
RC 49	RC 53	.05"	<b>RC 48</b>	RC 54
RC 49	RC 49	.07''	<b>RC 48</b>	RC 54
RC 50	RC 53	.09"	<b>RC 42</b>	RC 39
RC 41	RC 42	.11"	RC 45	RC 47
RC 43	RC 50	.13"	<b>RC 42</b>	RC 44
<b>RC 45</b>	<b>RC 48</b>	.15"	<b>RC 42</b>	RC 48
<b>RC 44</b>	<b>RC 48</b>	.21"	<b>RC 42</b>	RC 48
<b>RC 44</b>	<b>RC 48</b>	.27"	<b>RC 42</b>	RC 48
<b>RC 44</b>	<b>RC 48</b>	.33"	<b>RC 42</b>	RC 44

NOTE: HARDNESS TESTS WERE PERFORMED WITH A TUKON HARDNESS TESTER

**MACROSCOPIC AND MICROSCOPIC EVALUATIONS -**

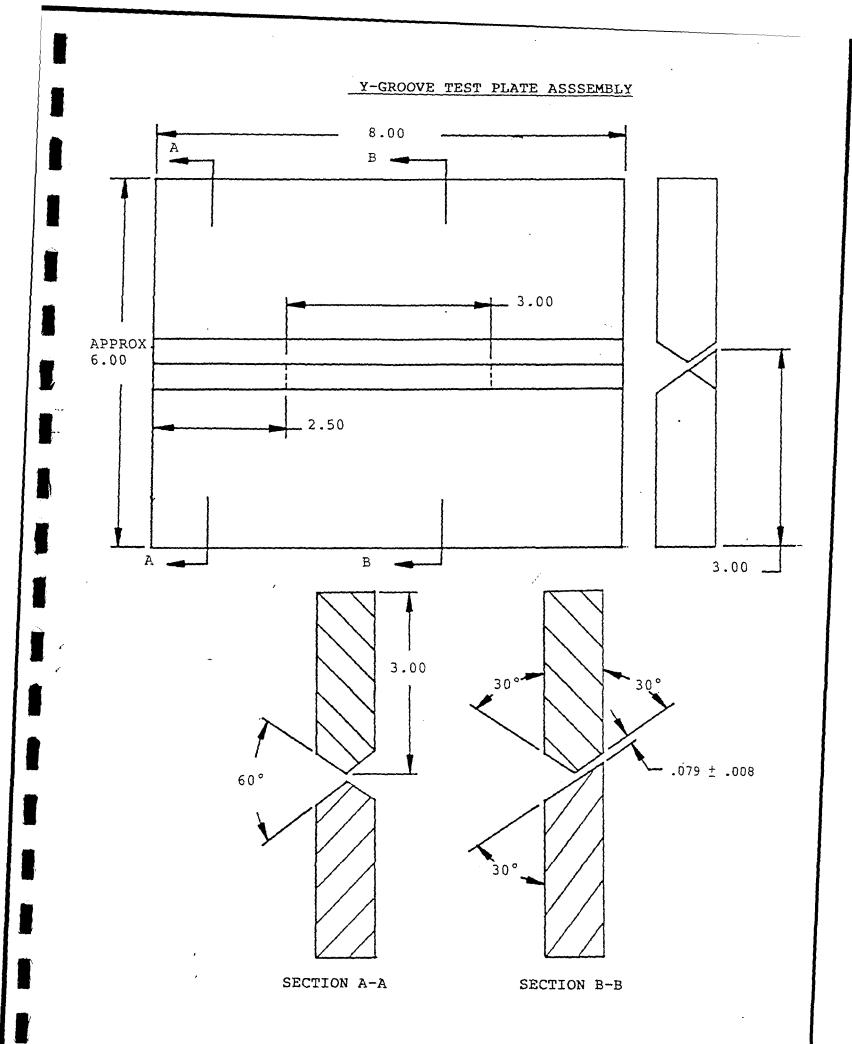
THE EVALUATIONS OF THE MACROSCOPIC AND MICROSCOPIC SPECIMENS REVEALED NO CRACKS OR LINEAR INDICATIONS.

SCANNING ELECTRONIC MICROSCOPE EVALUATIONS -

THERE WERE NO OBSERVED CRACKS IN THE SURFACE OF THE CUT EDGES AT 1000X MAGNIFICATION.

NOTE: THE SEM EVALUATIONS WERE PERFORMED BY BOWSER-MORNER, INC (BMI NO. 94040068)

**ATTACHMENT 6** WELDABILITY **DATA SHEETS** GENERAL DYNAMICS
LAND SYSTEMS DIVISION



# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	I-1 10-18-91 IRHA E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	28.0 250 375 IPM 13 IPM LINCOLN LA-100 .045 LOT 2752 32.3 KJ 95 Ar-5·0 <sub>2</sub> 45 CFH .75° .079
AMBIENT TEMPER	RATURE/

\_\_DC/EP

TYPE

DESSOP 1

PREHEAT (MIN.)

INTERPASS (MAX.)

ELECTRODE STICK-OUT

TIP RECESS

POSITION

JESSOP 1

300° F

N/A

25°

FLAT

WELD PROCESS

BASE MATERIAL

THICKNESS

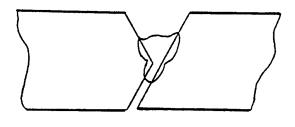
EDGE PREP

GMAW

IRHA

2.50"

FC/GRIND



JOINT DETAIL

#### **TEST RESULTS**

SECTION

A B C

NO CRACK

HUMIDITY

POLARITY

**CURRENT TYPE AND** 

COMMENTS

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. 1-2 DATE 10-18-91 PROGRAM IRHA THICKNESS 1.50' ENGINEER 28.0 AMPERAGE 250 WIRE SPEED 375 IPM TRAVEL SPEED 13 IPM DIA045 CONTROL NO. LOT 2752 HEAT INPUT 32.3 KJ SHIELDING GAS 95 Ar-5 0.2 FLOW RATE 45 CFH NOZZLE SIZE 75' ROOT OPENING .079  AMBIENT TEMPERATURE/ HUMIDITY  CURRENT TYPE AND POLARITYDC/FP  DOLARITYDC/FP  WELD PROCESS GMAW IRHA IRHA THICKNESS 1.50' TYPE JESSOP 1  PREHEAT (MIN.) 300° F INTERPASS (MAX.) N/A ELECTRODE STICK-OUT TIP RECESS .25' POSITION FLAT EDGE PREP FC/GRIND  CURRENT TYPE AND POLARITYDC/FP  JOINT DETAIL		
AMPERAGE 250 WIRE SPEED 375 IPM TRAVEL SPEED 13 IPM DIA	DATE 10-18-91 PROGRAM IRHA	BASE MATERIAL IRHA THICKNESS 1.50"
	AMPERAGE 250 WIRE SPEED 375 IPM TRAVEL SPEED 13 IPM WIRE TYPE LINCOLN LA-100 DIA045 CONTROL NO. LOT 2752 HEAT INPUT 32.3 KJ SHIELDING GAS 95 Ar-5 02 FLOW RATE 45 CFH NOZZLE SIZE .75* ROOT OPENING .079  AMBIENT TEMPERATURE/ HUMIDITY  CURRENT TYPE AND	INTERPASS (MAX.) ELECTRODE STICK-OUT TIP RECESS POSITION EDGE PREP FC/GRIND

## TEST RESULTS

SECTION COMMENTS

A B C

NO CRACK

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. 1-3  DATE 10-18-91  PROGRAM IRHA  ENGINEER E. JOHNSON	WELD PROCESS  BASE MATERIAL  THICKNESS  TYPE  GMAW  IRHA  2.50"  JESSOP 1
VOLTAGE 28.0  AMPERAGE 250  WIRE SPEED 375 IPM  TRAVEL SPEED 13 IPM  WIRE TYPE LINCOLN LA-100  DIA045  CONTROL NO. LOT 2752	PREHEAT (MIN.) 400° F INTERPASS (MAX.) N/A ELECTRODE STICK-OUT TIP RECESS .25" POSITION FLAT EDGE PREP FC/GRIND
HEAT INPUT  SHIELDING GAS  FLOW RATE  NOZZLE SIZE  ROOT OPENING  32.3 KJ  95 Ar-5 0 <sub>2</sub> 45 CFH  .75"  .75"	
AMBIENT TEMPERATURE/ HUMIDITY —————  CURRENT TYPE AND POLABITY DC/EP	
POLARITY <u>DC/FP</u>	JOINT DETAIL

# **TEST RESULTS**

SECTION COMMENTS

A B C

NO CRACK

# Y-GROOVE WELDABILITY TEST DATA SHEET

<del></del>			
TEST NO. DATE PROGRAM ENGINEER	1-4 10-18-91 IRHA E JOHNSON	WELD PROCESS BASE MATERIAL THICKNESS TYPE	GMAW IRHA 1.50" JESSOP 1
VOLTAGE	28.0	PREHEAT (MIN.)	400 <sup>0</sup> F
AMPERAGE	250	INTERPASS (MAX.)	N/A
WIRE SPEED	375 IPM	ELECTRODE STICK-OUT.	
TRAVEL SPEED	13 IPM	TIP RECESS .	.25*
WIRE TYPE	LINCOLN LA-100	POSITION .	FLAT
DIA.	.045	EDGE PREP .	FC/GRIND
CONTROL NO.	LOT 2752		
HEAT INPUT	32.3 KJ		
, SHIELDING GAS	95 Ar-5 0 <sub>2</sub>		
FLOW RATE	45 CFH		
NOZZLE SIZE	.75*		
ROOT OPENING	.079		/
			/
AMBIENT TEMPER	ATURE/		
HUMIDITY			}
	٠.	/	
CURRENT TYPE A	-		
POLARITY	DC/EP	JOINT DETA	II.

# **TEST RESULTS**

JOINT DETAIL

COMMENTS SECTION В C Α NO CRACK

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. 1-5  DATE 10-24-91  PROGRAM IRHA  ENGINEER E. JOHNSON	WELD PROCESS  BASE MATERIAL  THICKNESS  TYPE  GMAW  IRHA  2.50*  JESSOP 1
VOLTAGE 28.0  AMPERAGE 210  WIRE SPEED 315 IPM  TRAVEL SPEED 12 IPM  WIRE TYPE LINCOLN LA-100  DIA045  CONTROL NO. LOT 2752	PREHEAT (MIN.) 300° F INTERPASS (MAX.) N/A ELECTRODE STICK-OUT TIP RECESS .25° POSITION FLAT EDGE PREP FC/GRIND
HEAT INPUT  SHIELDING GAS  95 Ar-5 · 0 <sub>2</sub> FLOW RATE  45 CFH  NOZZLE SIZE  .75"  ROOT OPENING  AMBIENT TEMPERATURE/	
HUMIDITY ————————————————————————————————————	JOINT DETAIL

# TEST RESULTS

SECTION COMMENTS

A B C

NO CRACK

# Y-GROOVE WELDABILITY TEST DATA SHEET

1-6 TEST NO. 10-24-91 DATE IRHA PROGRAM E. JOHNSON **ENGINEER VOLTAGE** 28.0 **AMPERAGE** 210 315 IPM WIRE SPEED TRAVEL SPEED 12 IPM LINCOLN LA-100 WIRE TYPE DIA. .045 CONTROL NO. LOT 2752 HEAT INPUT 29.4 KJ 95 Ar-5 0 SHIELDING GAS FLOW RATE 45 CFH .75\* NOZZLE SIZE .079 ROOT OPENING AMBIENT TEMPERATURE/ HUMIDITY

**CURRENT TYPE AND** 

NO CRACK

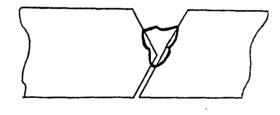
POLARITY

DC/EP

WELD PROCESS
BASE MATERIAL
THICKNESS
TYPE

GMAW
IRHA
1.50°
JESSOP 1

300<sup>0</sup> F



JOINT DETAIL

#### TEST RESULTS

SECTION COMMENTS

NOTES

Α

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	1-7 10-24-91 IRHA E JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING AMBIENT TEMPER HUMIDITY	28.0 210 315 IPM 12 IPM LINCOLN LA-100 .045 LOT 2752 29.4 KJ 95 Ar-5 0 <sub>2</sub> 45 CFH .75° .079
CURRENT TYPE A	ND DC/EP

PREHEAT (MIN.) 400° F
INTERPASS (MAX.) N/A
ELECTRODE STICK-OUT
TIP RECESS .25°
POSITION FLAT
EDGE PREP FC/GRIND

GMAW IRHA

2.50"

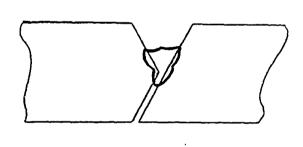
JESSOP 1

WELD PROCESS

BASE MATERIAL

**THICKNESS** 

**TYPE** 



JOINT DETAIL

# TEST RESULTS

SECTION COMMENTS

A B C

NO CRACK

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	1-8 10-24-91 IRHA E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING AMBIENT TEMPER	28.0 210 315 IPM 12 IPM LINCOLN LA-100 .045 LOT 2752 29.4 KJ 95 Ar-5 0 45 CFH .75" .079
HUMIDITY  CURRENT TYPE A	* Company of the Comp

DC/EP

PREHEAT (MIN.) 400° F
INTERPASS (MAX.) N/A
ELECTRODE STICK-OUT
TIP RECESS .25°
POSITION FLAT
EDGE PREP FC/GRIND

GMAW IRHA

1.50"

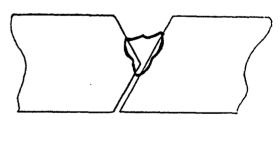
JESSOP 1

WELD PROCESS

BASE MATERIAL

**THICKNESS** 

TYPE



JOINT DETAIL

## **TEST RESULTS**

SECTION COMMENTS

A B C

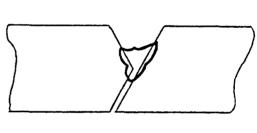
NO CRACK

NOTES

POLARITY

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	I-9 10-24-91 IRHA E. JOHNSON	WELD PROCESS GM BASE MATERIAL IR THICKNESS 2. TYPE JE
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO.	28.0 210 315 IPM 12 IPM LINCOLN LA-100 .045 LOT 2752	PREHEAT (MIN.)  INTERPASS (MAX.)  ELECTRODE STICK-OUT  TIP RECESS  POSITION  EDGE PREP  POSITION  TO SECURITY OF THE PRESE
HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	29.4 KJ 95 Ar-5 0 <sub>2</sub> 45 CFH .75"	
AMBIENT TEMPER HUMIDITY	RATURE/	
CURRENT TYPE A POLARITY	ND DC/EP	JOINT DETAIL



**GMAW** IRHA

2.50"

JESSOP 1

300<sup>0</sup> F

N/A

.25"\_ FLAT FC/GRIND

**TEST RESULTS** 

COMMENTS **SECTION** С В Α

NOTES

NO CRACK

# Y-GROOVE WELDABILITY TEST DATA SHEET

	TEST NO. DATE PROGRAM ENGINEER	1-10 10-24-91 IRHA E. JOHNSON	WELD PROCESS BASE MATERIAL THICKNESS TYPE	GMAW IRHA 1.50° JESSOP 1
	VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO.	28.0 210 315 IPM 12 IPM LINCOLN LA-100 .045 LOT 2752	PREHEAT (MIN.) INTERPASS (MAX.) ELECTRODE STICK-OUT TIP RECESS POSITION EDGE PREP	300° F  N/A  .25°  FLAT  FC/GRIND
	HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	29.4 KJ 95 Ar-5 0 <sub>2</sub> 45 CFH .75°		
	AMBIENT TEMPER HUMIDITY  CURRENT TYPE A POLARITY		JOINT DETA	AIL.
		<del></del>		

# TEST RESULTS

SECTION COMMENTS

A B C

NO CRACK

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	L-12 5-28-92 IRHA E. JOHNSON
VOLTAGE AMPERAGE	27.0
WIRE SPEED	300 IPM 8.57 IPM
TRAVEL SPEED WIRE TYPE	LINCOLN LA-100
DIA.	.045
CONTROL NO.	C1113 FK
HEAT INPUT	41586.93 J/IN.
SHI ELDING GAS	M5
FLOW RATE	45 CFH
NOZZLE SIZE	.750"
ROCT OPENING	.079"
AMBIENT TEMPER	
HUMIDITY _	<u>78° F/545%</u>

CURRENT TYPE AND

POLARITY

DC/EL POS

PREHEAT (MIN.)

INTERPASS (MAX.)

ELECTRODE STICK-OUT

750"

TIP RECESS

POSITION

EDGE PREP

600

600

GMAW-SPRAY

JESSUP

1.250"

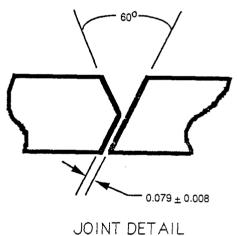
CLASS I .

WELD PROCESS

BASE MATERIAL

THICKNESS

TYPE



## TEST RESULTS

SECTION COMMENTS

A B C

CRACKED CRACKED

## Y-GROOVE WELDABIL'TY TEST DATA SHEET

TEST NO.	_L-13_
DATE	5-28-92
PROGRAM	IRHA
ENGINEER	E JOHNSON

WELD PROCESS
BASE MATERIAL
THICKNESS
TYPE

GMAW-SPRAY JESSUP 1.250"

CLASS I

200° F

500°

**VOLTAGE** 27.0 AMPERAGE 220 300 IPM WIRE SPEED TRAVEL SPEED 8.57 IPM WIRE TYPE LINCOLN LA-100 DIA. .045 CONTROL NO. CI113 FK HEAT INPUT 41586.93 J/IN. SHIELDING GAS M5

PREHEAT (MIN.)
INTERPASS (MAX.)
ELECTRODE STICK-OUT
TIP RECESS
POSITION
EDGE PREP

.750" .125" FLAT FC/GRIND

NOZZLE SIZE \_\_750"

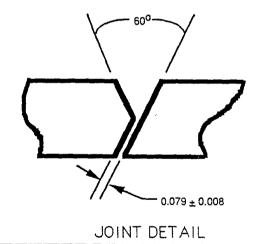
ROOT OPENING \_\_079"

AMBIENT TEMPERATURE/

45 CFH

FLOW RATE

CURRENT TYPE AND
POLARITY DC/FL POS



#### **IEST RESULTS**

SECTION COMMENTS

A B C
CRACKED CRACKED CRACKED

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-14
DATE	5-28-92
PROGRAM	IRHA
ENGINEER	E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	27.0 220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586.93 J/IN. M5 45 CFH .750" .079"

EDGE PREP FC/GRIND

JOINT DETAIL

ELECTRODE STICK-OUT \_\_\_750"

WELD PROCESS

BASE MATERIAL

**THICKNESS** 

PREHEAT (MIN.)
INTERPASS (MAX.)

TYPE

TIP RECESS POSITION

GMAW-SPRAY JESSUP

1.250"

CLASS I

200° F

5000

.125"

0.079 ± 0.008

FLAT

CURRENT TYPE AND
POLARITY DC/FL POS

78<sup>0</sup> F/54 5%

AMBIENT TEMPERATURE/

HUMIDITY -

#### TEST RESULTS

	SECTION		COMMENTS
A	В	С	
	CRACKED	CRACKED	CRACKED

## Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	<u>L-15</u>
DATE	5-28-92
PROGRAM	IRHA
ENGINEER	E JOHNSON
VOLTAGE	27.0

WELD PROCESS
BASE MATERIAL
THICKNESS
TYPE

GMAW-SPRAY

JESSUP

1.250"

CLASS I

VOLTAGE	27.0
AMPERAGE	220
WIRE SPEED	300 IPM
TRAVEL SPEED	8.57 IPM
WIRE TYPE	LINCOLN LA-100
DIA.	.045
CONTROL NO.	C1113 FK
HEAT INPUT	41586.93 J/IN.
SHIELDING GAS	M5
FLOW RATE	_45 CFH
NOZZLE SIZE	750"

PREHEAT (MIN.) 200° F
INTERPASS (MAX.) 500°
ELECTRODE STICK-OUT 750"
TIP RECESS .125"
POSITION FLAT
EDGE PREP FC/GRIND

AMBIENT TEMPERATURE/ HUMIDITY \_ 780 F/545%

ROOT OPENING

<u>.079</u>"

JOINT DETAIL

CURRENT TYPE AND
POLARITY
DC/FL POS

# **TEST RESULTS**

SECTION COMMENTS

A B C

NO CRACK NO CRACK NO CRACK NO CRACKS

#### Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.
DATE
PROGRAM
ENGINEER

L-16 5-28-92 IRHA

E. JOHNSON

THICKNESS

GMAW-SPRAY **JESSUP** 1.250" CLASS I

**VOLTAGE AMPERAGE** WIRE SPEED TRAVEL SPEED

27.0 220 300 IPM

WIRE TYPE

8.57 IPM LINCOLN LA-100

DIA. CONTROL NO.

.045 <u>C1113 FK</u>

HEAT INPUT SHIELDING GAS 41586.93 J/IN. M5

FLOW RATE NOZZLE SIZE 45 CFH

ROOT OPENING

.750" .079"

AMBIENT TEMPERATURE/ 78<sup>0</sup> F/545% HUMIDITY

CURRENT TYPE AND POLARITY

DC/EL POS

WELD PROCESS BASE MATERIAL TYPE

PREHEAT (MIN.)

200° F

500°

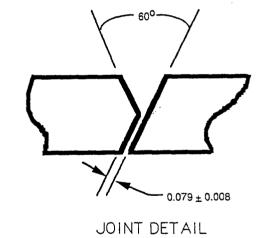
INTERPASS (MAX.)

ELECTRODE STICK-OUT \_\_\_750"

TIP RECESS

POSITION EDGE PREP .125"

FLAT FC/GRIND



#### **IEST RESULTS**

SECTION

COMMENTS

Α CRACKED В

CRACKED

C

CRACKED

CRACKED

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	L-17 6-10-92 !RHA E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	27.0 220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586.93 J/IN. M5 45 CFH .750" .079"

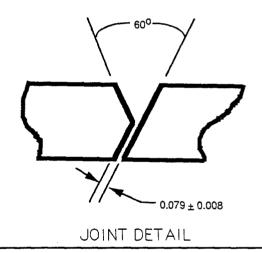
AMBIENT TEMPERATURE/
HUMIDITY 780 F/60%

CURRENT TYPT AND
POLARITY DC/EL POS

WELD PROCESS
BASE MATERIAL
THICKNESS
TYPE

GMAW-SPRAY
JESSUP
1.250"
CLASS I

PREHEAT (MIN.) 250° F
INTERPASS (MAX.) 500°
ELECTRODE STICK-OUT 750°
TIP RECESS 125°
POSITION FLAT
EDGE PREP FC/GRIND



#### TEST RESULTS

SECTION:

COMMENTS

A B C

NO CRACK NO CRACK NO CRACK

NO CRACKS

## Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-18
DATE	6-10-92
PROGRAM	IRHA
ENGINEER	E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	27.0 220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586.93 J/IN. M5 45 CFH .750" .079"

THICKNESS CLASS I TYPE 250° F PREHEAT (MIN.) INTERPASS (MAX.) 5000 ELECTRODE STICK-OUT \_\_\_750" 125" TIP RECESS POSITION FLAT FC/GRIND EDGE PREP

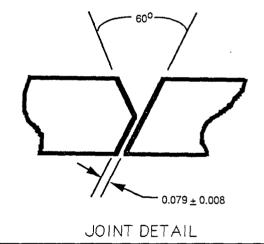
WELD PROCESS

BASE MATERIAL

GMAW-SPRAY

JESSUP

1.250"



CURRENT TYPE AND

AMBIENT TEMPERATURE/

POLARITY

HUMIDITY -

DC/EL\_POS

78<sup>0</sup> F/60%

#### TEST RESULTS

SECTION

COMMENTS

NO CRACK NO CRACK

В  $\mathsf{C}$ NO CRACK

NO CRACKS

## Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.
DATE
PROGRAM
ENGINEER

L-19 6-10-92 IRHA

E. JOHNSON

WELD PROCESS
BASE MATERIAL
THICKNESS
TYPE

PREHEAT (MIN.)

GMAW-SPRAY
JESSUP

1.250"
CLASS I

250° F

VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED 27.0

300 IPM 8.57 IPM

WIRE TYPE

LINCOLN LA-100

DIA. CONTROL NO.

C1113 FK

HEAT INPUT SHIELDING GAS 41586.93 J/IN.

FLOW RATE

M5 \_45 CFH

NOZZLE SIZE ROOT OPENING <u>.750"</u> .079"

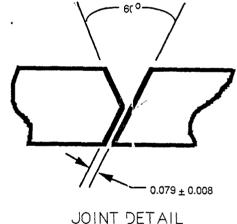
AMBIENT TEMPERATURE/
HUMIDITY - 78° F/60%

CURRENT TYPE AND

POLARITY

DC/EL POS

INTERPASS (MAX.) 500°
ELECTRODE STICK OUT 750°
TIP RECESS 125°
POSITION FLAT
EDGE PREP FC/GRIND



#### TEST RESULTS

SECTION

COMITENTS

A NO CRACK В

CRACKED

С

NO CRACK

CRACKED

## Y-GROOVE WELDABILITY TEST DATA SHEET

L-20 TEST NO. <u>6-10-92</u> DATE IRHA PROGRAM

E. JOHNSON

27.0

.045

M5

45 CEH

.750" .079"

C1113 FK

41586.93 J/IN.

AMPERAGE 220 WIRE SPEED 300 IPM 8.57 IPM

TRAVEL SPEED WIRE TYPE LINCOLN LA-100

ENGINEER

VOLTAGE

DIA.

CONTROL NO.

HEAT INPUT SHIELDING GAS

FLOW RATE

NOZZLE SIZE

ROOT OPENING

AMBIENT TEMPERATURE/ \_78º F/60% HUMIDITY -

CURRENT TYPE AND

POLARITY

DC/EL POS

WELD PROCESS BASE MATERIAL **THICKNESS** 

TYPE

1.250" CLASS I

PREHEAT (MIN.) INTERPASS (MAX.) ELECTRODE STICK-OUT \_\_

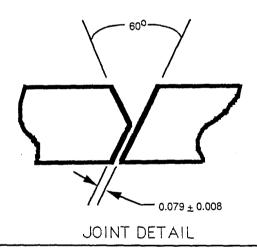
TIP RECESS POSITION EDGE PREP

250° F 500° .750"

GMAW~SPRAY

**JESSUP** 

125" FLAT FC/GRIND



#### TEST RESULTS

SECTION

В C

NO CRACK NO CRACK NO CRACK

COMMENTS

NO CRACKS

#### Y-GROOVE WELDABILITY TEST DATA SHEET

L-21 TEST NO. 6-10-92 DATE IRHA **PROGRAM** E. JOHNSON **ENGINEER** 

WELD PROCESS BASE MATERIAL THICKNESS. TYPE

GMAW-SPRAY JESSUP 1.250" CLASS I

**VOLTAGE** 27.0 **AMPERAGE** 220 300 IPM WIRE SPEED 8.57 IPM TRAVEL SPEED WIRE TYPE LINCOLN LA-100 DIA. .045 CONTROL NO. \_C1113 FK HEAT INPUT 41586.93 J/IN. SHIELDING GAS M5

PREHEAT (MIN.) INTERPASS (MAX.) ELECTRODE STICK-OUT \_\_\_750" TIP RECESS POSITION EDGE PREP

500° 125" FLAT FC/GRIND

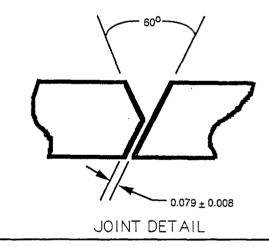
250° F

FLOW RATE NOZZLE SIZE ROOT OPENING

45 CFH .750" .079"

AMBIENT TEMPERATURE/ 78<sup>0</sup> F/60% HUMIDITY -

CURRENT TYPE AND \_ DC/EL\_POS\_ POLARITY



# TEST RESULTS

SECTION

COMMENTS

 $\mathsf{C}$ В Α NO CRACK NO CRACK NO CRACK

NO CRACKS

## Y-GROOVE WELDABILITY TEST DATA SHEET

DATE PROGRAM ENGINEER	6-9-92 IRHA E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED	27.0 220 300 IPM 8.57 IPM
WIRE TYPE . DIA.	LINCOLN LA-100 .045
CONTROL NO. HEAT INPUT	C1113 FK 41586.93 J/IN.
SHIELDING GAS FLOW RATE NOZZLE SIZI	M5 45 CFH .750"
ROOT OPENING	.079"

TEST NO.

L-22\_\_\_\_

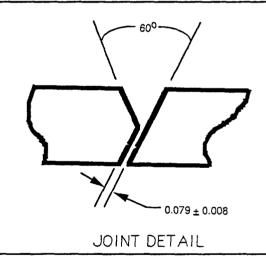
AMBIENT TEMPERATURE/
HUMIDITY - 840 F/60%

CURRENT TYPE AND
POLARITY DC/FL POS

WELD PROCESS
BASE MATERIAL
THICKNESS
TYPE

GMAW-SPRAY JESSUP 1.250" CLASS I

PREHEAT (MIN.) 300° F
INTERPASS (MAX.) 500°
ELECTRODE STICK-OUT .750°
TIP RECESS .125°
POSITION FLAT
EDGE PREP FC/GRIND



#### TEST RESULTS

SECTION C

NO CRACK

NO CRACK

COMMENTS

NO CRACKS

NOTES

NO CRACK

#### Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	L-23 6-9-92 IRHA E. JOHNSON
VOLTAGE	27.0
AMPERAGE	220
WIRE SPEED	300 IPM
TRAVEL SPEED	8.57 IPM
WIRE TYPE	LINCOLN LA-100
DIA	.045

WIRE TYPE

DIA.

CONTROL NO.

HEAT INPUT

SHIELDING GAS

FLOW RATE

NOZZLE SIZE

ROOT OPENING

LINCOLN LA-10

C1113 FK

41586.93 J/IN

45 CFH

750"

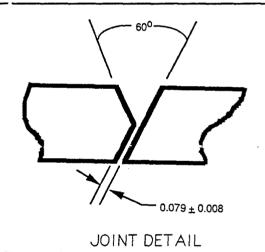
AMBIENT TEMPERATURE/
HUMIDITY - 840 F/60%

CURRENT TYPE AND
POLARITY DC/EL POS

WELD PROCESS
EASE MATERIAL
THICKNESS
TYPE

GMAW-SPRAY
JESSUP
1.250"
CLASS I

PREHEAT (MIN.) 300° F
INTERPASS (MAX.) 500°
ELECTRODE STICK-OUT .750"
TIP RECESS .125"
FOSITION FLAT
EDGE PREP FC/GRIND



#### TEST RESULTS

SECTION C

COMMENTS

NO CRACK NO CRACK

NO CRACKS

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-24
DATE	6-9-92
PROGRAM	IRHA
ENGINEER	E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	27.0 220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586.93 J/IN. M5 45 CFH .750"

AMBIENT TEMPERATURE/
HUMIDITY - 840 F/60%

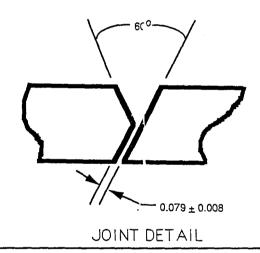
CURRENT TYPE AND
POLARITY
DC/FL POS

WELD PROCESS BASE MATERIAL THICKNESS TYPE

JESSUP 1.250" CLASS I

GMAW-SPRAY

PREHEAT (MIN.) 300° F
INTERPASS (MAX.) 500°
ELECTRODE STICK-OUT 750°
TIP RECESS .125°
POSITION FLAT
EDGE PREP FC/GRIND



#### TEST RESULTS

SECTION COMMENTS

A B C

NO CRACK NO CRACK NO CRACKS

# Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	L-25 6-9-92 IRHA E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	27.0 220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586.93 J/IN. M5 45 CFH .750" .079"
AMBIENT TEMPER HUMIDITY -	84º F/60%

CURRENT TYPE AND

POLARITY

\_ DC/EL\_POS

PREHEAT (MIN.) 300° F
INTERPASS (MAX.) 500°
ELECTRODE STICK-OUT 750°
TIP RECESS .125°
POSITION FLAT FC/GRIND

GMAW-SPRAY JESSUP

1.250"

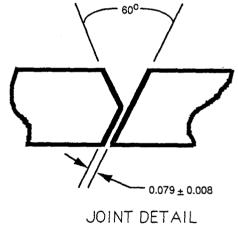
CLASS I

WELD PROCESS

BASE MATERIAL

THICKNESS

TYPE



## TEST RESULTS

		SECTION			COMMENTS
l	A	В	c I	~	
	NO CRACK	NO CRACK	NO CRACK	•	NO CRACKS

#### Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	L-26
DATE	6-9-92
PROGRAM	IRHA
ENGINEER	E JOHNSON

WELD PROCESS BASE MATERIAL THICKNESS TYPE

GMAW-SPRAY JESSUP 1.250" CLASS I

300° F

5000

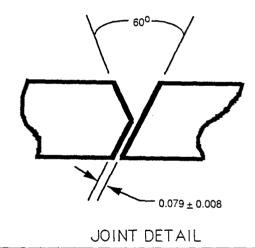
**VOLTAGE** 27.0 220 **AMPERAGE** 300 IPM WIRE SPEED 8.57 IPM TRAVEL SPEED WIRE TYPE LINCOLN LA-100 .045 DIA. CONTROL NO. C1113 FK HEAT INPUT 41586.93 J/IN. SHIELDING GAS M5 FLOW RATE 45 CFH .750" NOZZLE SIZE .079" ROOT OPENING

PREHEAT (MIN.) INTERPASS (MAX.) ELECTRODE STICK-OUT \_\_\_750" TIP RECESS POSITION EDGE PREP

125" FLAT FC/GRIND

AMBIENT TEMPERATURE/ 840 F/60% HUMIDITY -

CURRENT TYPE AND \_ DC/EL\_POS POLARITY



#### TEST RESULTS

COMMENTS SECTION Α В C NO CRACK NO CRACKS NO CRACK NO CRACK

## Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	L-27 6-19-92 IRHA E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS	27.0 220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586,93 J/IN.
FLOW RATE	<u>M5</u> 45 CFH

1.250" THICKNESS CLASS I TYPE 275° F PREHEAT (MIN.) · INTERPASS (MAX.) 500° ELECTRODE STICK-OUT \_\_\_750" .125" TIP RECESS

GMAW-SPRAY **JESSUP** 

FLAT

FC/GRIND

WELD PROCESS

BASE MATERIAL

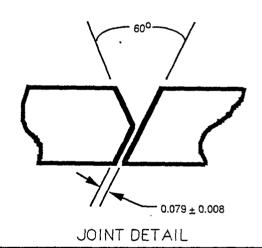
POSITION

EDGE PREP

NOZZLE SIZE .750" .079" ROOT OPENING

AMBIENT TEMPERATURE/ 830 F/67% HUMIDITY -

CURRENT TYPE AND DC/EL\_POS POLARITY



#### TEST RESULTS

COMMENTS SECTION В C Α NO CRACK NO CRACKS NO CRACK NO CRACK

#### Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO.	<u>L-28</u>
DATE	6-19-92
PROGRAM	IRHA
ENGINEER	E_JOHNSON

WELD PROCESS BASE MATERIAL THICKNESS TYPE

GMAW-SPRAY JESSUP 1.250" CLASS I

**VOLTAGE AMPERAGE** WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO.

220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586.93 J/IN.

27.0

PREHEAT (MIN.) INTERPASS (MAX.) ELECTRODE STICK-OUT \_\_750" TIP RECESS POSITION EDGE PREP

5000 125" FLAT FC/GRIND

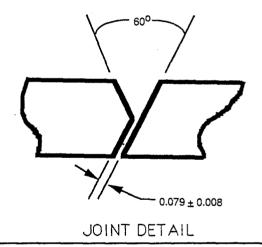
275° F

**HEAT INPUT** SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING

M5 45 CFH .750" .079"

AMBIENT TEMPERATURE/ 83<sup>0</sup> F/67% HUMIDITY -

CURRENT TYPE AND DC/EL POS POLARITY



# TEST RESU' IS

SECTION

COMMENTS

Α NO CRACK

В NO CRACK

NO CRACK

 $\mathsf{C}$ 

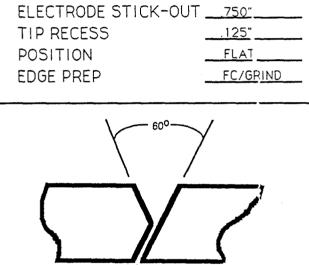
NO CRACKS

# Y-GROOVE WELDABILITY TEST DATA SHEET

DATE PROGRAM ENGINEER	6-19-92 IRHA E. JOHNSON
VOLTAGE AMPERAGE WIRE SPEED TRAVEL SPEED WIRE TYPE DIA. CONTROL NO. HEAT INPUT SHIELDING GAS FLOW RATE NOZZLE SIZE ROOT OPENING	27.0 220 300 IPM 8.57 IPM LINCOLN LA-100 .045 C1113 FK 41586.93 J/IN. M5 45 CFH .750" .079"

TEST NO.

L-29



- 0.079 ± 0.008

JOINT DETAIL

WELD PROCESS

BASE MATERIAL

**THICKNESS** 

PREHEAT (MIN.)
INTERPASS (MAX.)

TYPE

GMAW-SPRAY

JESSUP

1.250"

CLASS I

275° F

500°

CURRENT TYPE AND
POLARITY DC/FL POS

83<sup>0</sup> F/67%

AMBIENT TEMPERATURE/

HUMIDITY -

**IEST RESULTS** 

SECTION COMMENTS

A B C

NO CRACK NO CRACK NO CRACK NO CRACKS

## Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NO. DATE PROGRAM ENGINEER	L-30 6-19-92 IRHA E. JOHNSON		
VOLTAGE	27.0		
AMPERAGE	220		
WIRE SPEED	300 IPM		
TRAVEL SPEED	8.57 IPM		
WIRE TYPE	LINCOLN LA-100		
DIA.	.045		
CONTROL NO.	C1113 FK		
HEAT INPUT	41586.93 J/IN.		
SHIELDING GAS	_M5		
FLOW RATE	45 CFH		
NOZZLE SIZE	.750"		

AMBIENT TEMPERATURE/ HUMIDITY - 830 F/67%

ROOT OPENING

.079"

CURRENT TYPE AND
POLARITY DC/FL POS

WELD PROCESS
BASE MATERIAL
THICKNESS
TYPE

JESSUP 1.250" CLASS I

GMAW-SPRAY

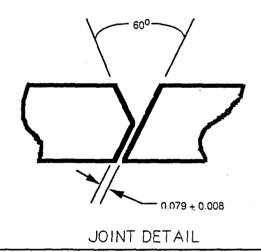
PREHEAT (MIN.) 275° F
INTERPASS (MAX.) 500°

ELECTRODE STICK-OUT .750"

TIP RECESS .125"

POSITION FLAT

EDGE PREP FC/GRIND



#### TEST RESULTS

SECTION COMMENTS

A B C

NO CRACK NO CRACK NO CRACK NO CRACKS

## Y-GROOVE WELDABILITY TEST DATA SHEET

TEST NC.	<u>L-31</u>
DATE	6-19-92
PROGRAM	IRHA ·
ENGINEER	E JOHNSON

WELD PROCESS BASE MATERIAL **THICKNESS** TYPE PREHEAT (MIN.)

INTERPASS (MAX.)

TIP RECESS

POSITION

EDGE PREP

ELECTRODE STICK-OUT \_\_750"

GMAW-SPRAY **JESSUP** 1.250" CLASS I

275° F

5000

125"

FLAT

FC/GRIND

**VOLTAGE** \_27.0 220 **AMPERAGE** 300 IPM WIRE SPEED 8.57 IPM TRAVEL SPEED WIRE TYPE .045 DIA. CONTROL NO. C1113 FK HEAT INPUT SHIELDING GAS M5 FLOW RATE 45 CFH NOZZLE SIZE

LINCOLN LA-100 41586.93 J/IN.

.750" .079"

AMBIENT TEMPERATURE/ \_83<sup>0</sup> F/67% HUMICITY -

ROOT OPENING

CURRENT TYPE AND DC/EL\_POS POLARITY

 $0.079 \pm 0.008$ JOINT DETAIL

#### **IEST RESULTS**

SECTION

COMMENTS

В C Α NO CRACK NO CRACK NO CRACK

NO CRACKS

**ATTACHMENT 7 STUD WELD DATA SHEETS GENERAL DYNAMICS** LAND SYSTEMS DIVISION

# **G.D.L.S. STUD WELD DATA SHEET**

PLATE SIZE 14" x 20" x 1.50"

PLATE MATERIAL IMPROVED RHA

MACHINE TYPE TRW NELSON TR-2400

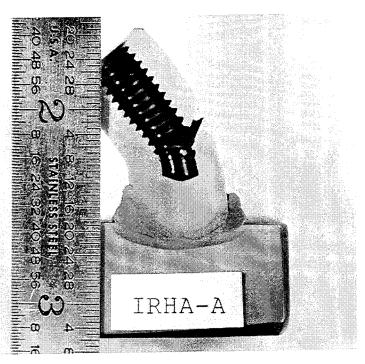
SURFACE CONDITION SHOT BLAST

DATE MAY 2, 1994
WELDED BY ED JOHNSON

SETTINGS \ PART NO.	12337637-4	12337637-26	12323577-8	12323577-2
STUD MATERIAL	MILD STEEL	MILD STEEL	S. STEEL	S. STEEL
THREAD SIZE	1/4-20UNC-2B	1/4-20UNC-2B	3/4-10UNC-2A	1/2-13UNC-2A
STUD DIAMETER	0.50"	0.625"	0.75"	0.50"
LIFT	0.062"	0.062"	0.093"	0.093"
PLUNGE	.190"	.190"	.280"	.185"
DAMPENING	2.50	2.50	2.50	2.50
CURRENT/POLARITY	DCEN	DCEN	DCEN	DCEN
WELD POSITION	FLAT	FLAT	FLAT	FLAT
FREE TRAVEL	.125"	.125"	.125"	.190"
AMPERAGE	750	1050	1400	650
TIME (SECONDS)	0.50	0.60	0.675	0.43
# STUDS WELDED	15	15	15	15
#STUDS BEND TESTED	10	10	10	10
BEND TEST RESULTS	10 STUDS FAIL - NO WELDS FAIL	NO STUDS FAIL - NO WELDS FAIL	10 STUDS FAIL - NO WELDS FAIL	NO STUDS FAIL - NO WELDS FAIL
#STUDS DYE PENT. INSPECTED	10	10	10	10
DYE PENT. RESULTS	NO CRACKS	NO CRACKS	NO CRACKS	NO CRACKS
METALOGRAPHIC EVALUATION RESULTS	100% FUSION	100% FUSION	100% FUSION	100% FUSION

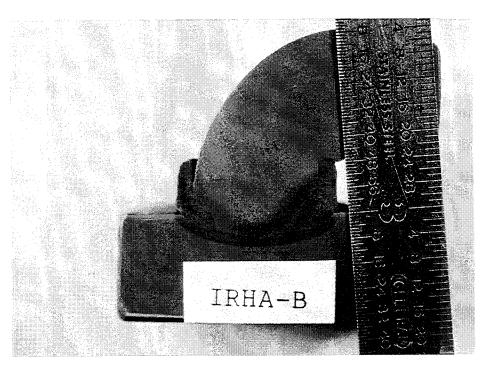
**TESTS PERFORMED PER MIL-STD.248** 

# ATTACHMENT 7 - STUD WELD QUALIFICATION



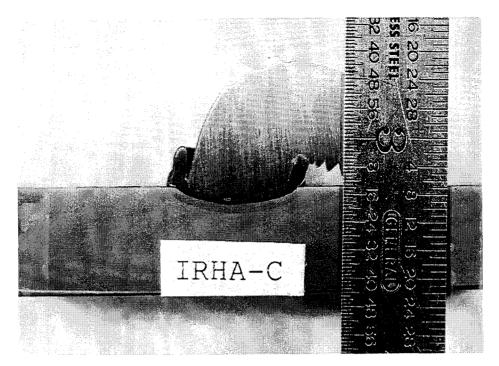
BASE METAL IMPROVED
STUD MATERIAL MILD STEEL
STUD SIZE 0.50" DIAME

IMPROVED HARDNESS RHA
MILD STEEL
0.50" DIAMETER



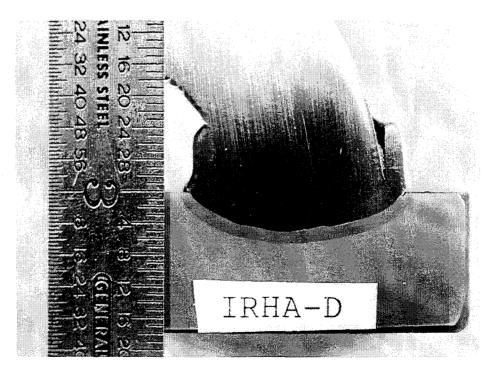
BASE METAL STUD MATERIAL STUD SIZE IMPROVED HARDNESS RHA
MILD STEEL
0.625" DIAMETER

## ATTACHMENT 7 - STUD WELD QUALIFICATION



STUD SIZE

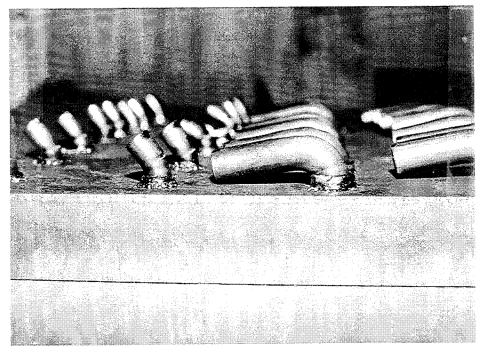
BASE METAL <u>IMPROVED HARDNESS RHA</u> STUD MATERIAL STAINLESS STEEL 0.50" DIAMETER



**BASE METAL** STUD MATERIAL STUD SIZE

IMPROVED HARDNESS RHA STAINLESS STEEL 0.75" DIAMETER

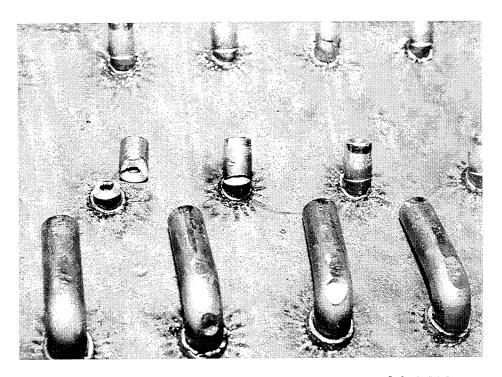
# ATTACHMENT 7 - STUD WELD QUALIFICATION TYPICAL BEND TEST RESULTS



BASE METAL IMPROVED IS STUD MATERIAL MILD STEEL 0.50" AND 0.6

IMPROVED HARDNESS RHA
MILD STEEL

0.50" AND 0.625" DIAMETER

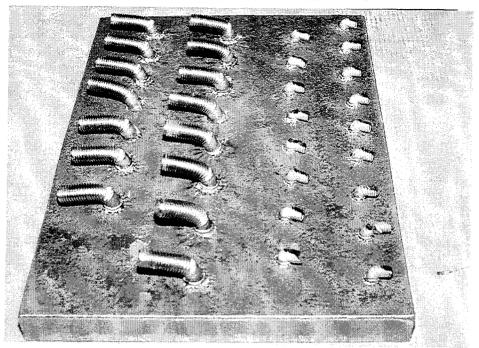


BASE METAL STUD MATERIAL STUD SIZE

MILD STEEL

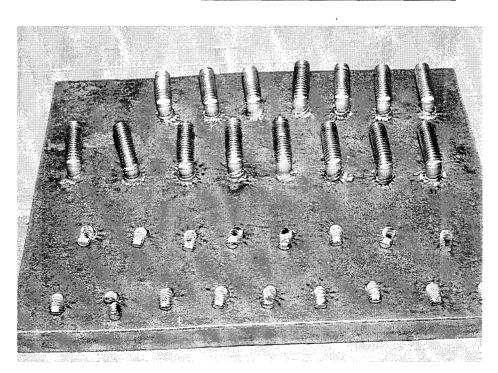
0.50" AND 0.625" DIAMETER

# ATTACHMENT 7 - STUD WELD QUALIFICATION TYPICAL BEND TEST RESULTS



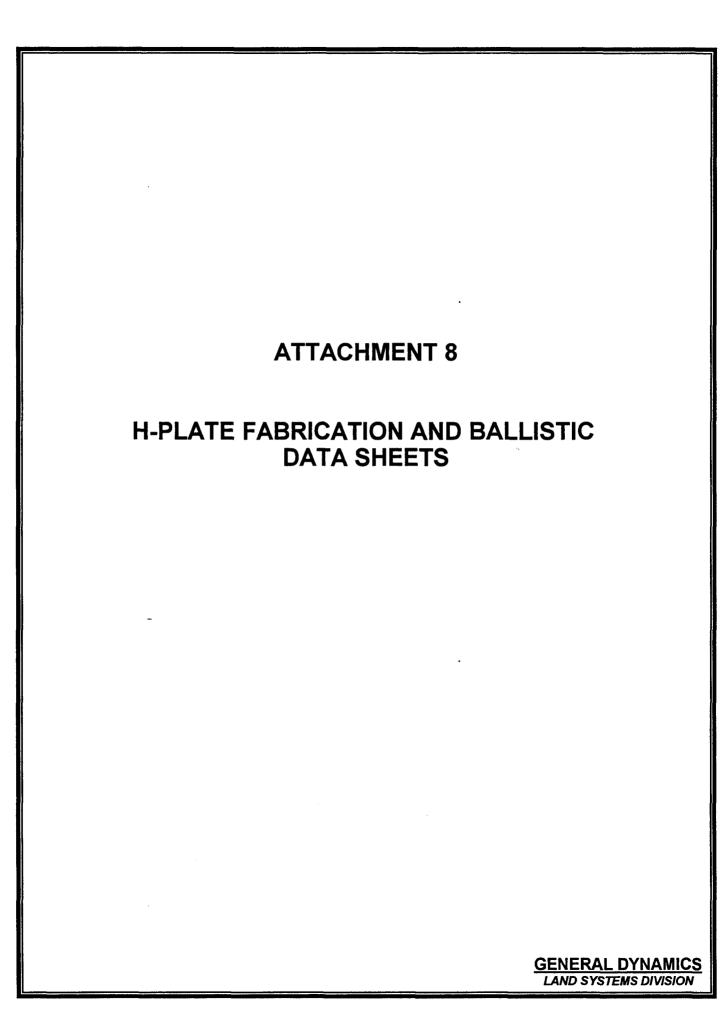
BASE METAL STUD SIZE

**IMPROVED HARDNESS RHA** STUD MATERIAL STAINLESS STEEL 0.50" AND 0.75" DIAMETER



BASE METAL STUD SIZE

IMPROVED HARDNESS RHA STUD MATERIAL STAINLESS STEEL 0.50" AND 0.75" DIAMETER



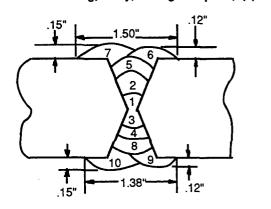
FORM 1 REPORT NO: **WELD ARMOR DATA** SHEET 1 OF SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 74 **APRIL 10, 1992** DATE: LAND SYSTEMS DIVISION 1161 BUCKEYE ROAD TYPE: 3 LIMA, OHIO 45804 1.5" THICKNESS: SPECIFICATION: CONTRACT NO: DAAL04-91-C-0040 MIL-A-12560G

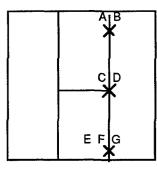
**ORDNANCE MATERIAL CONCERNED: RHA ARMOR** 

DAVID HOLLON WELDED BY:

OBJECT: **BALLISTIC SHOCK TEST** 

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





RIGHT LEG

Weld reinforcement (has) (has not) been removed.

#### **WELDING DATA**

NOZZLE COATING: NONE	JOINT COATING: NONE					
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC					
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX					
WELDING: GMAW SEMI-AUTOMATIC/ROBOT						

· · · · · · · · · · · · · · · · · · ·													
	WELDI	,	3.M.A.W.	SEMI-AL	TOMATIO	C/ROBOT							
	PREH	EAT:	200 F				POSTHE	POSTHEAT: NONE					
1	PEENI	PEENING: NONE						NG: NON	E				
		ELEC	TYPE	CLEAN	AMPC	VOLT	WIRE	WELD	INTERPASS TEMP (°F)				
ı	PASS	SIZE	PASS	CLEAN	AMPS	VOLI	SPEED	LENGTH	A-B	C-D	E-F-G		
l	1	.045	s	WB	295	26.8	451	39" / 3:14	200	200	200		
D	2	.045	S	_WB	395	32.1	752	40" / 2:18	205	210	205		
٦	3	.045	S	WB	285	26.6	450	40" / 3:33	205	210	208		
	4	.045	S	WB	400	32.1	752	41" / 2:16	205	205	210		
	5	.045	S	WB	437	38.0	1000	40" / 2:04	200	200	200		
1	6	.045	S	WB	457	38.0	1000	40" / 2:38	205	210	210		
	7	.045	s	WB_	439	38.0	1000	40" / 2:38	210	210	215		
	8	.045	S	WB	427	38.0	1000	40" / 2:05	200	200	200		
	9	.045	s	WB	442	38.0	1000	40" / 2:40	205	205	205		
	10	.045	s	WB_	448	38.0	1000	40" / 2:40	205	210	210		
	11		<u> </u>										
1	12			NOTE:	ROTAR	FILE AL	STARTS A	ND STOPS					
	13		<u> </u>										

BACKGRIND

14

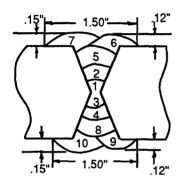
ORM 1 REPORT NO: **WELD ARMOR DATA** SHEET 2 OF 6 SUBMITTED BY: GENERAL DYNAMICS PLATE NO: DATE APRIL 14, 1992 LAND SYSTEMS DIVISION TYPE: 1161 BUCKEYE ROAD LIMA, OHIO 45804 1.5" THICKNESS: SPECIFICATION: MIL-A-12560G CONTRACT NO: DAAL04-91-C-0040

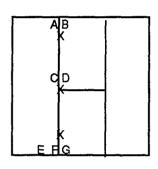
**ORDNANCE MATERIAL CONCERNED: RHA ARMOR** 

WELDED BY: DAVID HOLLON

**BALLISTIC SHOCK TEST** OBJECT:

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





LEFT LEG

Weld reinforcement (has) (has not) been removed.

#### **WELDING DATA**

NOZZLE COATING: NONE	JOINT COATING: NONE					
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC					
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX					
WELDING: G.M.A.W. SEMI-AUTOMATIC / ROBOTIC	(DCEP)					
PREHEAT: 200 F	POSTHEAT: NOME					

NONE

PEENI	PEENING: NONE						BUTTERING: NONE					
DASS	PASS SIZE		CLEAN	AMPS	VOLT	WIRE	WELD	INTERF	INTERPASS TEMP (°F)			
FAGG	SIZE	PASS	0227.11	<i>,</i>		SPEED	LENGTH	A-B	C-D	E-F-G		
1	.045	s_	WB	285	26.7	450	41" / 5:05	205	210	210		
2	.045	s_	WB	400	32.1	750	41" / 2:35	210	215	_215_		
3	.045	S	WB	285	26.7	450	41" / 5:05	200	200	205		
4	.045	S	WB	400	32.1	750	41" / 2:35	205	205	210		
5	.045	S	WB	407	38.0	1000	41" / 2:13	205	205	210		
6	.045	S	WB	415	38.0	1000	41" / 2:38	210	210	215		
7	.045	S	WB	416	38.0	1000	41" / 2:38	215	215	220		
8	.045	S	WB	446	38.0	1000	41" / 2:03	200	200	200		
9	.045	S	WB	444	38.0	1000	41" / 2:38	205	205	210		
10	.045	s	WB	445	38.0	1000	41" / 2:38	210	210	215		
11												
12			NOTE:	ROTAR	/ FILE AL	STARTS A	ND STOPS					
13												
14												

**BACKGRIND** 

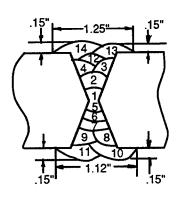
REPORT NO: FORM 1 **WELD ARMOR DATA** SHEET 3 OF 6 SUBMITTED BY: GENERAL DYNAMICS 74 PLATE NO: LAND SYSTEMS DIVISION APRIL 21, 1992 DATE: 1161 BUCKEYE ROAD TYPE: LIMA, OHIO 45804 1.5" THICKNESS: CONTRACT NO: DAAL04-91-C-0040 SPECIFICATION: MIL-A-12560G

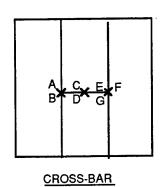
ORDNANCE MATERIAL CONCERNED: RHA ARMOR

WELDED BY: DAVID HOLLON
OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up,

if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





Weld reinforcement (has) (has not ) been removed.

					N	/ELDING	3 DATA						
	NOZZI	E COAT	ING: N	IONE			JOINT CO	JOINT COATING: NONE					
:	PLATE	PREPAR	RATION:	GRIN	ID		BACKING	TAPE: 45 C	ERAMIC				
	POSIT	ION OF V	VELDING	FLAT		SHIELDIN	SHIELDING GAS: 95%AR - 5%OX						
	WELDI	NG: G	.M.A.W.			(DCEP)							
	PREH		200 F				POSTHE	AT: NONE					
	PEENI		ONE			BUTTER	NG: NON						
·		ELEC	TYPE	CLEAN	AMPS	VOLT	WIRE	WELD	INTERP	ASS TEN			
	PASS	SIZE	PASS	CLEAN	CLEAN AMPS VOLT	VOLI	SPEED	LENGTH	A-B	C-D	E-F-G		
	1	.045	S	WB	295	26.7	451	8.25 / 0:46	205	210	205		
	2	.045	S	WB	300	26.7	451	9.25 / 0:45	210	210_	206		
	3_	.045	S	WB	295	26.7	451	9.62 / 0:29	210	215	216		
BACKGRIND	4	045	S	WB	295	26.7	451	9.62 / 0:32		210	210		
DAORGAMO	5	.045	S	WB	285	26.7	450	8.25 / 0:43		200	200		
	6	.045	S	WB	395	32.1	750	8.75 / 0:36	205 205	208	207		
	7	045	s	WB	295	26.7	450	10.25 / 0:30 10.25 / 0:27		209	207		
	8	045	S	WB	325	<u>26.7</u>	450	11.25 / 0:28		210 215	210 210		
	9	045	S	WB	425	36.0	950 950	11.50 / 0:30		215	210		
	10 11	045	S	WB WB	450 295	36.0 26.7	450	10.25 / 0:35		208	200		
	12	.045 .045	S	WB	325	26.7	450	10.25 / 0:28		205	200		
	13	.045	s	WB	460	36.1	950	11.25 / 0:27	202	205	200		
-	14	045	S	WB	460	36.0	951	11.25 / 0:28		205	200		

FORM 2								RE	PORT NO:				
				ARI	MOR P	LATE	DAT		EET 4 OF				
PLATE N	NO: 74	$T_{-}$		PLATE	Ē "A"				PLATE "B"				
MANUF	ACTURER	i: Lu	kens Ste					1					
TYPE:					ous Armo	or Plate							
THICKN	ESS:		50"										
HEAT N	0:												
LOT NO:		$\top$											
PROCES	SS:	T A	C/DQ	3									
CHEMICAL COMPOSITION													
	С	MN	SI	P	s		R.	NI	МО	ZR	V	CU	
TEST #1	.2724	1.270	.2476	.0092	.0038	.14	195	.1187	.5149	.0000	.0053	.2065	
TEST #2			[	Γ				<u> </u>				I	
HEAT TP	EATED BY	Y:		H	EAT TR	EATING	G DAT	ΓΑ					
TABLE I					ELECT	RODE	DATA	\					
SIZE	M/	ANUFAC	TURER		TR	ADE NA	ME		TYPE		CI	_ASS	
.045"	Lincoln E	Electric			LA	- 100			Mil- E-2376	35/2	Mil-1	00S-1	
		<u> </u>					<del></del>				<del></del>		
TABLE II													
MANUFACTURER CHEMICAL ANALYSIS TRADE NAME													
AND SIZ			1	C MN SI S				P	CR	NI	мо	co	
		CORE	WIRE	.0455	1.311	.2979	.0057			1.784	.4146	.0023	
LA - 100	/ .045"		METAL		1.511	.2919	.000,	1.00-	.0707	1./5	.4140	.0020	
	····		WIRE					†	<del></del>	<del>                                     </del>			
İ			METAL		<b> </b>			<del>                                     </del>					
-			WIRE					†	<del> </del>	<del>                                     </del>			
			METAL			<b></b>		<del> </del>	<del> </del>	<del>                                     </del>			
TABLE	II (AUTO!			G)						<u></u>			
	NUFACTU		<u></u>	<del></del>	ADE NA	ME			SIZE		FLUX		
	<del></del>												
					-				<del></del>	$\neg$			
RADIOG	RAPHED I	BY:											
RADIOG	RAPH SEF	RIAL NO	).										
REMARK	· O -			d in fabri	ooting th	o oroseb	or wole	1 (10) (1	o not) the	2000 00			
	1110						ai weic	) (is) <del>(</del> i	s not) the	same as	uie		
procedure used in fabricating the leg welds.													
5455104	700 050	DE051"	= 4 = 11 / / / /				DEOLE	SENIOE :	NORFOTO	<del> </del>	BUANCE		
	TOR REP					- 1	HESIL	DENCE	NSPECTO	H OF OR	DNANCE	=	
	'/n . /			_ `									

FORM 3	(1) REPORT NO.							
WELD RADIOGRAPHIC REPORT	SHEET NO 5 OF 6							
(2) X-RAY SERIAL NO: HP # 74								
(3) PLATE SUBMITTED BY: GDLS (4) PLATE NO. HP #74	(5) SPEC. ASTM-E390							
(6) RADIOGRAPHED BY: GDLS (7) DATE:								
1.5" 420 KV 10 MA	TIME (12) FOCAL DIST. 2.4 MIN. 42"							
(13) TYPE OF FILM KODAK 'M' (14) SCREENS OR	FILTERS .010 F & B							
SHOCK TEST PLATE								
SHOWING LOCATION OF RADIOGRAPHS AND RESULTS	OF TESTS							
5 i i i i i i i i i i i i i i i i i i i								
(15) LEGEND: CRACK ### INCOMPLETE FUSION	III INCOMPLETE III PENETRATION							
	CUTTING							
(4e) DECILITO								
(16) RESULTS								
1-2 SCATTERED POROSITY - STD I								
3-4 SCATTERED POROSITY - STD I	٠							
5-6 SCATTERED POROSITY - STD I								
7-8 SCATTERED POROSITY - STD I								
X-BAR SLAG AND SCATTERED POROSITY - STD I								
(17) NEGATIVES READ BY: L. M. Seay (18) GOV'T Q. A. R.	EP. John W. Green							
76	V4/34/9Z							

FORM 4

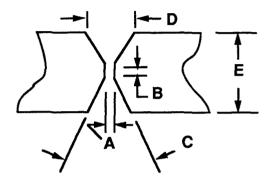
REPORT NO.

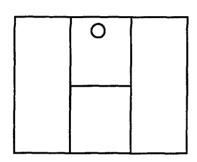
SHEET \_\_\_\_ OF \_

#### **INSPECTION CHECK SHEET**

H-PLATE NO. \_\_\_74\_\_\_\_

**CONTRACT NO.** \_5T5T000001





- A) ROOT GAP .09"
  B) ROOT FACE .06
- C) INCLUDED ANGLE 45° + 5°, -0°
  D) BEVEL OPENING 57"-65"
- E) PLATE THICKNESS \_\_1.50"

DATE INSPECT 4-14-92 RIGHT LEG FIT-UP 4-14-92 LEFT LEG FIT-UP CROSS-BAR FIT-UP

**DISCREPENCIES AND/OR DEVIATIONS** 



# DEPARTMENT OF THE ARMY U. S. ARMY COMBAT SYSTEMS TEST ACTIVITY ABERDEEN PROVING GROUND, MARYLAND 21005-5069



Advanced Armor Division

Date: June 21, 1994

Manufacturer : General Dynamics address : 1161 Buckeye Road

Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows:

Firing Record No.: 940669

Plate No.: 74

Contract No: DAAL04-91-C00040

Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel (fps)	Act Vel (fps)	Total Weld Cracking (in)	pass fail
1	RHA	1.490	75-mm M1002	1194	1204	1"	Pass

Sample no. 74 passed the ballistic requirements of MIL-STD-1946A. The sample sustained a 1" zone cracking on the impact side and no cracking on the opposite side from test impact. The sample passed the radiographic requirements of MIL-STD-1946A performed by USACSTA.

If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

JAMES P. FINFERA

Richard E fatherin

Chief, Advanced Projects Division

FORM 1 REPORT NO: **WELD ARMOR DATA** SHEET OF SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 106 DATE: FEBRUARY 23, 1994 LAND SYSTEMS DIVISION 1161 BUCKEYE ROAD TYPE: LIMA, OHIO 45804 1.5" THICKNESS: CONTRACT NO: SPECIFICATION: MIL-A-12560G DAAL04-91-C-0040

ORDNANCE MATERIAL CONCERNED: I-RHA ARMOR

NONE

WELDED BY: ED JOHNSON

NOZZLE COATING:

.045

.045

10

11 12

> 13 14

S

S

WB

**WB** 

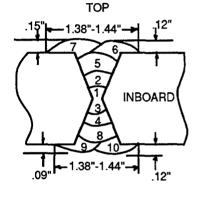
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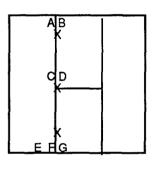
447

461

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any; (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





LEFT\_LEG\_

39" / 2:03

39" / 2:03

310

310

310

320

310

315

NONE

JOINT COATING:

Weld reinforcement (has) (has not) been removed.

#### **WELDING DATA**

PLATE	PREPAI	RATION:	GRIN	D	BACKING	BACKING TAPE: 45 CERAMIC				
POSIT	ION OF V	WELDING	FLAT		SHIELDII	NG GAS: 95	%AR - 5%	OX		
WELD	ING: c	A.M.A.W.	SEMI-AU	TOMATIO	C (H.C.D.)					
PREH		300 F MIN	MUMIN			POSTHE	AT: NONE			
PEENI	NG: N	IONE				BUTTERI	NG: NON			
DACC	ELEC	TYPE	CLEAN	AMPS	VOLT	WIRE	WELD	INTERF	ASS TEN	ИР (°F)
PASS	SIZE	PASS	OLEAN	AWI 0	, , , ,	SPEED	LENGTH	A-B	C-D	E-F-G
1	.045	s_	WB	300	27.0	450	39" / 2:45	310	310	310
2	.045	S	_WB	420	32.0	750	39" / 2:18	300	305	305
3	.045	s	BG	300	27.0	450	39" / 2:47	310	310	310
4	.045	s	WB	420	32.3	750	39" / 2:25	330	345	340
5	.045	s	WB	470	38.5	1000	39" / 2:03	310	310	310
6	.045	s	WB	470	38.5	1000	39" / 2:03	310	345	310
7	.045	s	WB	470	38.5	1000	39" / 2:03	305	310	320
8	.045	s	WB	478	38.3	1000	39" / 2:03	305	310	320

BACKGRIND

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

1000

1000

STARTS AND STOPS

38.3

ROTARY FILE AL

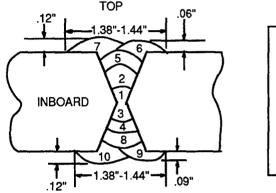
FORM 1 REPORT NO: **WELD ARMOR DATA** SHEET OF SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 106 FEBRUARY 23, 1994 LAND SYSTEMS DIVISION DATE: TYPE: 1161 BUCKEYE ROAD LIMA, OHIO 45804 THICKNESS: CONTRACT NO: SPECIFICATION: DAAL04-91-C-0040 MIL-A-12560G I-RHA

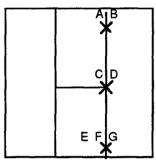
ORDNANCE MATERIAL CONCERNED:

WELDED BY: **ED JOHNSON** 

**BALLISTIC SHOCK TEST** OBJECT:

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





RIGHT LEG

Weld reinforcement (has) (has not) been removed.

#### **WELDING DATA**

NOZZLE COATING: NONE	JOINT COATING: NONE
PLATE PREPARATION: GRIND	BACKING TAPE: 45 CERAMIC
POSITION OF WELDING FLAT	SHIELDING GAS: 95%AR - 5%OX

	WELDI	ING: (	3.M.A.W.	SEMI/RC	BOT (H.C								
	PREH	EAT:	300 F MIN	NIMUM			POSTHE	POSTHEAT: NONE					
	PEENI	PEENING: NONE						NG: NON	Ε				
	ELEC	ELEC	TYPE	01.5411	AMBO	VOLT	WIRE	WELD	INTERF	ASS TEN	/IP (°F)		
	PASS	SIZE	PASS	CLEAN	AMPS	VOLI	SPEED	LENGTH	A-B	C-D	E-F-G		
	1	.045	s	WB	300	27.0	450	39" / 3:08	310	305	310		
D	2	.045	s	WB	420	32.3	750	39" / 2:18	310	310	305		
	3	.045	s	BG	300	27.0	450	39" / 3:10	310	315	315		
	4	.045	s	WB	420	32.3	750	39" / 2:55	300	310	300		
	5	.045	s	WB	476	38.3	1000	39" / 2:03	305	310	315		
	6	045	s	WB	_448	38.3	1000	39" / 2:03	300	300	310		
	7	.045	s	WB	465	38.3	1000	39" / 2:03	315	320	330		
	8	.045	s	WB	482	38.3	1000	39" / 2:03	305	305	305		
	9	.045	s	WB	432	38.3	1000_	39" / 2:03	315	315	320		
	10	.045	s	WB	459	38.3	1000	39" / 2:03	320	320	325		
	11		<u> </u>					<u></u>					

BACKGRINE

13 14

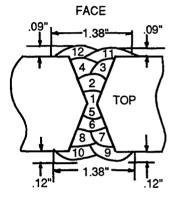
S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

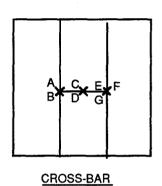
NOTE: ROTARY FILE ALL STARTS AND STOPS

FORM 1	LD ARMOR DATA	REPORT NO:				
	ELD ANIMON DATA	SHEET OF				
PLATE NO: 106	SUBMITTED BY: G	ENERAL DYNAMICS				
DATE: FEBRUARY 25, 1994 LAND SYSTEMS DIVISION						
TYPE: 3		161 BUCKEYE ROAD				
THICKNESS: 1.5"	L	LIMA, OHIO 45804				
SPECIFICATION: MIL-A-12560G	CONTRACT NO:	DAAL04-91-C-0040				
ORDNANCE MATERIAL CONCERNED:	I-RHA ARMOR					
WELDED BY: ED JOHNSON						

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any; (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





Weld reinforcement (has) (has not ) been removed.

	WELDING DATA												
	NOZZI	LE COAT	ING: N	NONE			JOINT CO	JOINT COATING: NONE					
i	PLATE	PREPA	RATION:	GRIN	ID .		BACKING	BACKING TAPE: 45 CERAMIC					
	POSITION OF WELDING FLAT							NG GAS: 95%	6AR - 5%	ох			
	WELD	NG: c	M.A.W.	SEMI-AU	TOMATIO								
	PREH	EAT: (	300 F MIN	MUMIN		POSTHE	AT: NONE	•					
	PEENING: NONE							NG: NON					
	2400	ELEC	TYPE	CLEAN	AMPS	VOLT	WIRE	WELD	INTERF	PASS TEN	/IP (°F)		
	PASS	SIZE	PASS	CLEAN	AIVII 3	.021	SPEED	LENGTH	A-B	C-D	E-F-G		
	1	.045	s	WB	320	27.0	450	10.00" / 0:47	305	305	305		
	2	.045	_s_	WB	330	28.0	450	11.25" / 1:13	315	315	315		
	3	045	s	WB	340	28.0	450	11.75" / 0:48	310	310	310		
BACKGRIND		045	<u> </u>	WB	340	28.0	450	11.75" / 0:52	305	310	305		
	5	.045	S	BG	310	27.0	450	10.00" / 0:55	305	305	305		
	6	.045	s_	WB	340	28.0	450	11.25" / 1:10		300	300		
	7	.045	<u>s</u>	WB	330	28.0	450	11.25" / 0:46		305	300		
	8	.045	S	WB	340	28.0	450	11.25" / 0:53		310	305		
	9	.045	S	WB	450	36.5	800	11.75" / 0:50		315	310		
	10	045	s	WB	440	36.5	800	11.50" / 0:42		305	300		
	_11	.045	S	WB	_470	36.5	008	12.50" / 0:55		310	305		
[	12	.045	_S	WB	340	28.0	450	12.75" / 1:00	310	315	310		
	13												
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S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

FORM 2				ADI	MAD D		DAT		ORT NO:				
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	NO: 106			PLATE	Ξ "A"			+		PLATE "E	3"		
	ACTURER		. S. STEE					<del> </del>					
TYPE:			MPROVEI	<u>) HARD</u>	NESS H	HA		<del></del>					
			.50"					+					
HEAT NO		<del>- -</del>	97840					<del></del>					
LOT NO:		<del></del>						<del> </del>					
PROCES	:S:		DUENCH		EMPEREI EMICAL		POSITI	ION _					
	С	MN	SI	P	s		CR	NI	MO	ZR	V	CU	
TEST #1	.26	.40	.40	.012	.004		.47	3.21	.53	.03	.011	.02	
TEST #2											T		
	REATED BY	V·		Н	EAT TR	EATING	G DAT	A					
		1	-		ELECT	RODE	DATA					•	
TABLE I				<del></del>	<del></del>		·	<del></del>					
SIZE			CTURER			RADE NA	ME	<del></del>	TYPE		CLASS		
.045"	Lincoln E	<u>Electric</u>			<u>LA</u>	- 100		M	lil- E-2376	5/2	Mil-100S-1		
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TABLE	1												
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1 400	. 0458		WIRE	.0455	1.311	.2979	.0057	.0047	.0494	1.784	.4146	.0023	
LA - 100	/ .045		METAL					I'	<u> </u>	[]			
		<u> </u>	WIRE		<b> </b>	<b></b>		<u> </u>		<b></b>		l	
			O METAL	<b></b>	<b>  </b>	<b></b>	<b></b>	<u> </u>	<del> </del>	<b></b>	<b>—</b>	<del></del>	
-			E WIRE		<b></b>	<b></b>		<b></b> '	<b></b> !	<b></b>	<b></b>		
			METAL				L		<u> </u>			L	
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MAI	NUFACTU	RER		<u>ı</u>	RADE NA	ME		SIZ	<u>′E</u>	+	FLUX		
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	RAPH SEF			***	<del></del>								
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	ATOR REP						KEOIDI	ENCE IIV	SPECIO	A OF OIL	DIVANUL	=	
W 11 1 .		///											

FORM 3 WELD RADIOGRAPHIC REF	PORT (1) REPORT NO.
(2) X-RAY SERIAL NO:	SHEET NOOF
R #2054	
(3) PLATE SUBMITTED BY: GDLS (4) PLATE NO. HP #106	(5) SPEC. ASTM-E390 STD. II
	7) DATE: 03 MARCH 1994
(8) PLATE THICKNESS: (9) KV (10) MA 10 M	(11) TIME (12) FOCAL DIST MA 1.5 - 1.9 MIN. 42"
	ENS OR FILTERS .010 F & B
SHOCK TEST PLATE	E
SHOWING LOCATION OF RADIOGRAPHS AND RE	ESULTS OF TESTS
7 13 14 14 18	
(15) LEGEND: CRACK #### INCOMPLET FUSION	PENETRATION
··· POROSITY AND SLAG INCLUSIONS	UNDERCUTTING
(16) RESULTS	
1-2 SCATTERED POROSITY - STD I	
3-4 SCATTERED POROSITY - STD I	
5-6 SCATTERED POROSITY - STD I	
7-8 SCATTERED POROSITY - STD I	
X-BAR SCATTERED POROSITY - STD I	
(17) NEGATIVES READ BY: L. Seay (18) GOV'T	ΓQ. A. REP. N/R
83	

FORM 4

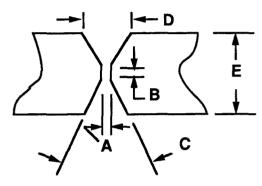
REPORT NO.

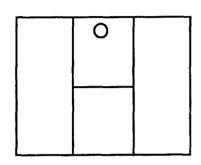
SHEET \_\_\_\_ OF \_\_\_\_

#### **INSPECTION CHECK SHEET**

H-PLATE NO. 106

CONTRACT NO. DAAL04-91-C-0040





- c) INCLUDED ANGLE 450

	<u>DATE</u>	INSPECTOR	Ĺ
RIGHT LEG FIT-UP	2-22-94	R A	,
LEFT LEG FIT-UP	2-22-94	2	7
CROSS-BAR FIT-UP	2-22-94	Du S	•

**DISCREPENCIES AND/OR DEVIATIONS** 



# DEPARTMENT OF THE ARMY U.S. ARMY COMBAT SYSTEMS TEST ACTIVITY ABERDEEN PROVING GROUND, MARYLAND 21005-5069



Advanced Armor Division

Date: June 21, 1994

Manufacturer : General Dynamics address : 1161 Buckeye Road

Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows:

Firing Record No.: 940670

Plate No.: 106

Contract No: DAAL04-91-C00040

						Total Weld	
Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel (fps)	Act Vel (fps)	Cracking (in)	pass fail
1	RHA	1.494	75-mm M1002	1194	1210	5-1/8"	Pass

Sample no. 106 passed the ballistic requirements of MIL-STD-1946A. The sample sustained no cracking on the impact side and 5-1/8" weld cracking on the opposite side from test impact. The sample passed the radiographic requirements of MIL-STD-1946A performed by USACSTA.

If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

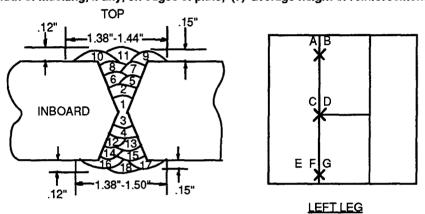
JAMES P. FINFERA

Richard E Satham

Chief, Advanced Projects Division

FORM 1 WELD AF	RMOR DATA	REPORT NO:
PLATE NO: 107	SUBMITTED BY:	SHEET_OF_
DATE: MARCH 2, 1994		GENERAL DYNAMICS  LAND SYSTEMS DIVISION
TYPE: 3		1161 BUCKEYE ROAD
THICKNESS: 1.5"		LIMA, OHIO 45804
SPECIFICATION: MIL-A-12560G	CONTRACT NO:	DAAL04-91-C-0040
ORDNANCE MATERIAL CONCERNED: I-RHA		
WELDED BY: ED JOHNSON		

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.



Weld reinforcement (has) (has not ) been removed.

## WELDING DATA NOZZLE COATING: NONE JOINT COATING:

**BALLISTIC SHOCK TEST** 

**OBJECT:** 

	NOZZI	E COAT	ING: N	ONE			JOINT CO	DATING: NO	NE				
•	PLATE	PREPAR	RATION:	GRIN	1D		BACKING	BACKING TAPE: 45 CERAMIC					
	POSIT	ION OF V	VELDING	FLAT			SHIELDIN	SHIELDING GAS: 95%AR - 5%OX					
	WELDI	NG: G	.M.A.W.	SEMI-AU	TOMATI	C SPRAY	DEW PC	INT -88.6 F					
	PREH	AT: 3	300 F MIN	IIMUM			POSTHE	AT: NONE					
	PEENI	NG: N	ONE				BUTTER	NG: NON					
	PASS	ELEC	TYPE	CLEAN	AMPS	VOLT	WIRE	WELD		ASS TEM	1P (°F)		
	FASS	SIZE	PASS	0227	,		SPEED	LENGTH	A-B	C-D	E-F-G		
	1	.062	S	WB	340	27.0	200	39.50" / 3:23	305	310	305		
BACKGRIND	2	.062	S	WB	350	28.0	195	39.50" / 4:15	305	310	305		
	3	.062	s	BG	330	26.5	200	40.00" / 3:44	310	315	310		
	4	.062	s	WB	_350_	28.0	195	40.00" / 4:18	315	315	320		
	5	.062	S	WB	310	27.5	170	40.00" / 2:48	320	320	320		
	6	.062	S	WB	330	27.5	180	40.00" / 3:25	305	305	305		
	7	.062	s	WB	330	27.5	170	40.00" / 3:10	310	310	310		
	8	.062	S	WB	320	27.5	170	40.00" / 3:00	300	305	300		
	9	062	S	WB	340	28.0	180	39.00" / 2:50	310	315	310		
	10	062	S	WB	340	28.0	180	39.00" / 3:05	310	315	305		
	11	062	s	WB	330	28.0	180	39.00" / 3:00	305	320	300		
	12	062	S	WB	320	27.5	180	39.50" / 2:57	310	320	320		
	13	062	S	WB	_320	27.0	180	39 50" / 3:16	300	305	300		
	14	062	S	WB	330	27.0	180	39.50" / 2:55	320	325	330		
	15	062	S	WB	330	27.0	180	39.50" / 3:00	330	330	330		
	16	.062	S	WB	_330	28.0	180	39.50" / 3:00	310	310	310		
	17	.062	S	WB	330	28.0	180	39.50" / 3:00	310	310	310		

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

180

27.5

86

39.50" / 3:00

310

310

S

062

18

FORM 1 **REPORT NO: WELD ARMOR DATA** SHEET SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 107 DATE: MARCH 2, 1994 LAND SYSTEMS DIVISION TYPE: 1161 BUCKEYE ROAD THICKNESS: 1.5" LIMA, OHIO 45804 CONTRACT NO: SPECIFICATION: DAAL04-91-C-0040 MIL-A-12560G

**ORDNANCE MATERIAL CONCERNED:** I-RHA

**ED JOHNSON** WELDED BY:

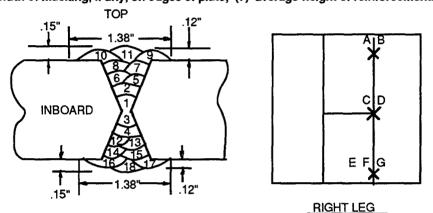
**BALLISTIC SHOCK TEST** OBJECT:

s

062

18

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.



Weld reinforcement (has) (has not) been removed.

WELDING DATA

#### NOZZLE COATING: NONE JOINT COATING: NONE **GRIND** 45 CERAMIC BACKING TAPE: PLATE PREPARATION: POSITION OF WELDING FLAT SHIELDING GAS: 95%AR - 5%OX WELDING: G.M.A.W. SEMI-AUTOMATIC SPRAY DEW POINT -88.6 F PREHEAT: POSTHEAT: NONE 300 F MINIMUM PEENING: NONE **BUTTERING:** NONE WELD INTERPASS TEMP (°F) WIRE TYPE **ELEC CLEAN AMPS VOLT PASS** SPEED **LENGTH** SIZE **PASS** A-B C-D E-F-G .062 330 26.5 310 310 310 S **WB** 200 39.50" / 4:55 S 350 28.0 40.50" / 4:35 310 315 320 .062 **WB** 195 **BACKGRIND** 3 s .062 26.5 40.00" / 3:53 325 330 320 BG 340 200 4 062 s 350 28.0 40.00" / 4:15 310 330 330 **WB** 195 5 S 062 **WB** 320 27.5 40.00" / 2:30 310 305 305 120 6 S 27.5 062 WB. 330 180 40.00" / 3:15 335 330 330 7 S WB 330 305 062 27.5 40.00" / 2:13 315 305 170 8 S 062 **WB** 335 27.5 180 40.00" / 3:00 320 320 320 S 9 **WB** 062 330 28.0 180 39.00" / 3:05 325 330 325 10 S **WB** 310 062 340 28.0 180 39.00" / 3:00 320 315 11 062 S **WB** 335 28.0 120 39 00" / 3:00 305 310 305 12 S WB 320 062 27.0 180 39.50" / 2:33 350 350 350 S 13 **WB** 062 320 27.0180 39.50" / 3:00 350 350 350 S 14 **WB** 062 320 27.0 180 39.50" / 2:53 330 340 330 15 S **WB** 330 39.50" / 2:45 325 330 330 062 27.5 180 16 s WB 062 330 28.0 180 39.50" / 2:45 330 330 330 S WB 39.50" / 2:45 17 330 062 28.0 180 320 325 330

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

185

39.50" / 2:45

320

320

27.5

330

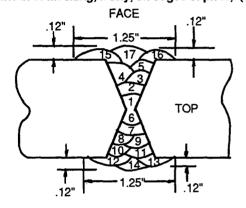
FORM 1 REPORT NO: **WELD ARMOR DATA** SHEET OF SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 107 MARCH 7, 1994 LAND SYSTEMS DIVISION DATE: 1161 BUCKEYE ROAD TYPE: LIMA, OHIO 45804 1.5" THICKNESS: SPECIFICATION: CONTRACT NO: DAAL04-91-C-0040 MIL-A-12560G

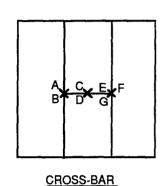
ORDNANCE MATERIAL CONCERNED: I-RHA

WELDED BY: ED JOHNSON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





Weld reinforcement (has) (has not) been removed.

**WELDING DATA** 

	***************************************												
	NOZZ	LE COAT	ING: N	ONE			JOINT CO	JOINT COATING: NONE					
	PLATE	PREPAR	RATION:	GRIN	1D		BACKING	BACKING TAPE: 45 CERAMIC					
	POSIT	ION OF V	VELDING	FLAT			SHIELDI	NG GAS: 95%	6AR - 5%	OX			
	WELDI	NG: G	.M.A.W.	SEMI-AU	TOMATI	C SPRAY	DEW PO	OINT -88.6 F		- <u> </u>			
	PREH	EAT: 3	300 F MIN	IIMUM			POSTHE	AT: NONE					
	PEENI	NG: N	ONE				BUTTER	ING: NON	E				
	ELEC		TYPE PASS	CLEAN	AMPS	VOLT	WIRE SPEED	WELD LENGTH		ASS TEM			
	.,,,,,	SIZE	PASS				SPEED	LENGIA	A-B	C-D	E-F-G		
	1	.062	S	WB	330	26.5	200	9.50" / 0:46	310	310	310		
	2	.062	S	WB	350	28.0	195	10.00" / 1:10	320	310	320		
	3	.062	S	WB	330	27.5	190	11.00" / 0:53	300	305	300		
	4	.062	S	WB	330	27.5	190	11.00" / 0:57	330	330	330		
BACKGRIND	5	.062	s	WB	340	27.5	190	11.00" / 0:42	330	335	_330		
DAGRAIME	6	.062	S	BG	320	26.5	200	9.50" / 1:06	330	330	330		
	7	.062	S	WB	340	28.0	200	10.50" / 1:26	300	310	300		
	8	.062	s	WB	330	27.5	190	11.25" / 1:05	300	310	300		
	9	062	S	WB	340	27.5	190	11.50" / 1·10	310	320	325		
	10	062	S	WB	340	27.5	190	12.00" / 1:00	315	320	320		
	11	062	S	WB	340	27.5	190	12.00" / 0:50	305	315	305		
	12	062	S	WB	330	27.5	180	12.00" / 1:03	325	330	325		
	13	062	S	WB	330	27.5	180	12 00" / 1:00	325	330	325		
	14	062	S	WB	340	28.0	180	12.00" / 1:00	310	315	315		
	15	062	S	WB	340	27.5	180	12.00" / 1:00	340	340	340		
	16	.062	S	WB	340	27.5	180	12.00" / 1:00	330	335	330		
	17	.062	S	WB	340	28.0	180	12.00" / 1:00	310	315	310		

S=Stringer Bead W=Weave Pass WB=Wire Brush BG=Background

ROTARY FILE ALL STARTS AND STOPS

F-22-1-2														
FORM 2				ARI	MOR P	LATE	DA	ТА		ORT NO: ET 4 OF				
PLATE N	NO: 107		<del> </del>	PLATE				丁	O1 1-		PLATE "E			
	ACTURER:	. U. S.	STEEL		<u>- 0</u>			十			<u> </u>	,		
TYPE:					NESS RI	HA		1_						
THICKNE	ESS:	1.50"			·			工						
HEAT NO	0:	9784												
LOT NO:	:													
PROCES	iS:	QUE	NCH A	AND TE	MPERE	D		l						
					EMICAL		POSIT	NOL	<u> </u>				<del>-</del>	
	С	MN :	SI	Р	s		CR		NI_	MO	ZR	V	cu	
TEST #1	.26	.40 .	.40	.012	.004	1_1	1.47	3	3.21	.53	.03	.011	.02	
TEST #2												T	T	
	REATED BY	γ:		HI	EAT TR	EATIN	G DAT	ΓΑ						
					ELECT	RODE	DATA	1		- Marie	<del></del>		<del></del>	
TABLE I									T		<del></del>			
SIZE		ANUFACTU	JRER	-+		RADE NA	AME		<u> </u>	TYPE		CLASS		
.062"	Lincoln E	Electric	lectric			- 100			M	lil- E-2376	35/2	Mil-1	100S-1	
									<b></b>					
			<u></u>											
TABLE II		<del></del>												
MANUFA TRADE N	ACTURER NAME		<del></del>		<del></del>	CH	IEMICA	L AI	NALY	SIS	<del>, ,</del>			
AND SIZE		ł .		С	MN	SI	s		Р	CR	NI I	МО	СО	
		CORE WI	IRE	.049	1.68	.48	.003		007	.05	1.94	.45		
LA - 100	/ .062"	WELD ME					† <u> </u>	1	<del>,,,,</del>					
		CORE W						1						
		WELD ME						1_						
-		CORE W	/IRE					<b>T</b> _						
		WELD ME	ETAL					工						
	II (AUTON		LDING											
MAI	NUFACTU	RER		TR	RADE NA	ME			SIZ	<u>ZE</u>		FLUX		
			—				<del> </del>							
			L_		<del></del>							<del></del> ,		
RADIOG	RAPHED B	3Y: LARF	RY SEA	<del>1</del> Υ										
RADIOGI	RAPH SER	IAL NO. F	R #2052	2										
REMARK	S: The	procedure	used i	in fabric	cating the	e crosst	oar wek	d (is	a) <del>(is</del>	net) the	same as	the		
		cedure use						- ,	<i>'</i> 7 、		00	,,,,,,		
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	TOR REP						RESID	DENC	CE IN	SPECTO	R OF OR	DNANCE	=	
17/1		Thear	à										ļ	

FORM 3	(1) REPORT NO.
WELD RADIOGRAPHIC REPORT	SHEET NOOF
(2) X-RAY SERIAL NO: R #2052	
(3) PLATE SUBMITTED BY: GDLS (4) PLATE NO. HP #107	(5) SPEC. ASTM-E390 STD. II
(6) RADIOGRAPHED BY: GDLS (7) DATE:	21 APRIL 1994
	TIME (12) FOCAL DIST. 5 - 2.0 MIN. 42"
(13) TYPE OF FILM KODAK 'M' (14) SCREENS OR	
SHOCK TEST PLATE SHOWING LOCATION OF RADIOGRAPHS AND RESULTS O	OF TESTS
(15) LEGEND: CRACK ### INCOMPLETE FUSION	INCOMPLETE PENETRATION
	CUTTING
(16) RESULTS	
1-2 SCATTERED POROSITY - STD I	
3-4 SCATTERED POROSITY - STD I	
5-6 SOUND	
7-8 SCATTERED POROSITY - STD I	
X-BAR SCATTERED POROSITY - STD	
(17) NEGATIVES READ BY: L. N. SOGY (18) GOV'T Q. A. RE	EP. N/R

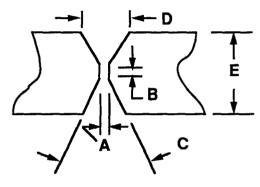
REPORT NO.

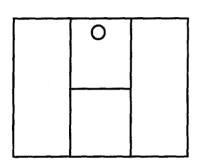
SHEET \_\_\_ OF \_

### **INSPECTION CHECK SHEET**

H-PLATE NO. \_\_107

CONTRACT NO. DAALO4-91-C-0040





- C) INCLUDED ANGLE 45°
  D) BEVEL OPENING 69" .75"
  E) PLATE THICKNESS 1.50"
  - **RIGHT LEG FIT-UP** LEFT LEG FIT-UP **CROSS-BAR FIT-UP**

DATE	INSPECTOR	
3-1-94	2 ()	7
3-1-94	R ON	ì
3-1-94		

**DISCREPENCIES AND/OR DEVIATIONS** 



# DEPARTMENT OF THE ARMY U. S. ARMY COMBAT SYSTEMS TEST ACTIVITY ABERDEEN PROVING GROUND, MARYLAND 21005-5059



REPLY TO ATTENTION OF

Advanced Armor Division

Date: June 21, 1994

Manufacturer : General Dynamics address : 1161 Buckeye Road

Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows:

Firing Record No.: 940671

Plate No.: 107

Contract No: DAAL04-91-C00040

Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel	Act Vel (fps)	Total Weld Cracking (in)	pass fail
1	RHA	1.499	75-mm M1002	1200	1205	none	Pass

Sample no. 107 passed the ballistic requirements of MIL-STD-1946A. The sample sustained no cracking on the impact side and no cracking on the opposite side from test impact. The sample passed the radiographic requirements of MIL-STD-1946A performed by USACSTA.

If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

Mihard E. fathan In JAMES P. FINFERA

Chief, Advanced Projects Division

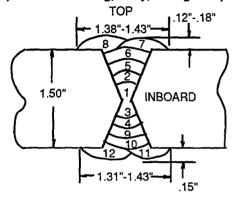
VFORM 1 **REPORT NO: WELD ARMOR DATA** SHEET OF SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 108 DATE: APRIL 4, 1994 LAND SYSTEMS DIVISION 1161 BUCKEYE ROAD TYPE: LIMA, OHIO 45804 THICKNESS: 1.50" SPECIFICATION: MIL-A-12560 DAAL04-91-C-0040 **CONTRACT NO:** 

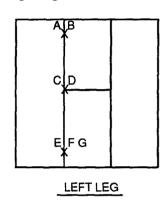
ORDNANCE MATERIAL CONCERNED: IMPROVED HARDNESS RHA

WELDED BY: ED JOHNSON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any; (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





Weld reinforcement <del>(hae)</del> (has not ) been removed.

**WELDING DATA** 

WLLDING DATA												
NOZZ	LE COAT	ING: N	ONE			JOINT COATING: NONE						
PLATE	PREPAI	RATION:	GROUN	ND		BACKING	BACKING TAPE: CERAMIC					
POSIT	TON OF V	VELDING	VERT	CAL		SHIELD	ING GAS: 95%	6 AR - 5%	S OX			
WELD	ING: G	MAW SE	MI-AUTO	MATIC -	DEW PO	DINT: -86.1 F						
PREH	EAT: 3	300 F				POSTHE	AT: NONE					
PEEN	NG: NO	ONE				BUTTER	RING: NONE					
PASS	ELEC	TYPE	CLEAN	AMPS	VOLT	WIRE	WELD	INTERF	PASS TEN	ЛР (°F)		
FASS	SIZE	PASS	CLEAN	AIVIPS	VOLT	SPEED	LENGTH	A-B	C-D	E-F-G		
1	045	s	WB	135	20.3	230	38.50" / 8:05	310	315	310		
2	.045	W	WB	130	19.1	195	38.50" / 7:10	315	315	320		
3	.045	S	BG	125	19.8	200	38.50" / 6:30	320	315	310		
4	.045	W	WB	130	19.1	195	38.50" / 8:00	345	345	340		
5	.045	W	WB	135	19.8	195	38.50" / 9:17	315	320	325		
6	.045	W	WB	135	19.8	195	38.50" / 12:33	325	325	325		
7	.045	W	WB	110	18.5	140	38.50" / 14:45	325	330	335		
8	.045	W	WB	110	18.6	140	38.50" / 14:05	325	325	330		
9	.045	W	WB	135	19.6	195	38.50" / 9:07	325	325	320		
10	.045	W	WB	140	19.8	200	38.50" / 13:48	310	320	320		
11	.045	W	WB	110	19.3	140	38.50" / 12:13	325	315	310		
12	.045	W	WB	110	19.3	140	38.50" / 13:00	330	335	330		
13												
14												
15												
16	ĺ	[	i		İ		1					

**BACKGRIND** 

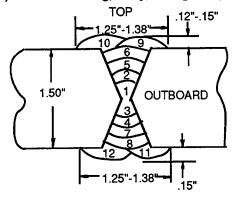
**REPORT NO:** FORM 1 **WELD ARMOR DATA** SHEET 2 OF 6 SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 108 LAND SYSTEMS DIVISION MARCH 31, 1994 DATE: 1161 BUCKEYE ROAD TYPE: LIMA, OHIO 45804 THICKNESS: 1.50" DAAL04-91-C-0040 SPECIFICATION: MIL-A-12560 CONTRACT NO:

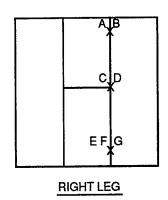
ORDNANCE MATERIAL CONCERNED: IMPROVED HARDNESS RHA

WELDED BY: ED JOHNSON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





Weld reinforcement -(hae) (has not ) been removed.

**WELDING DATA** 

ı	NOZZI	E COAT	ING: N	ONE		JOINT COATING: NONE						
	PLATE	PREPAR	RATION:	GROUN	<b>I</b> D	BACKING TAPE: CERAMIC						
	POSIT	ON OF W	VELDING	VERTI	CAL	SHIFI DI	NG GAS: 95%	AR - 5%	OX			
	WELD	NG: G	MAW SE	MI-AUTC		PULSE	1	INT: -86.1 F				
	PREH		00 F			POSTHE		•				
	PEENI		ONE					ING: NONE				
	PEENI	ELEC	TYPE				WIRE	WELD	INTERP	ASS TEM	MP (°F)	
	PASS	SIZE	PASS	CLEAN	AMPS	VOLT	SPEED	LENGTH	A-B	C-D	E-F-G	
	1	045	S	WB	145	20.8	230	38.50" / 5:49	310	310	310	
,	2	.045	W	WB	135	20.8	195	38,50" / 8:35	320	325	320	
,	3	.045	S	BG	120	20.6	200	38.50" / 6:53	320	325	320	
	4	.045	W	WB	135	20.8	195	38.50" / 10:00	325	330	325	
	5	.045	W	WB	130	20.8	195	38.50" / 9:45	310	310	305	
	6	.045	W	WB	135	20.3	195	38.50" / 10:07	310	315	305	
	7	.045	W	WB	130	19.8	195	38.50" / 9:25	320	315	310	
	8	.045	W	WB	130	19.8	195	38.50" / 11:15	315	320	325	
	9	.045	W	WB_	110	19.1	140	38.50" / 12:49	325	325	325	
	10	.045	W	WB	115	19.3	140	38.50" / 12:46	345	340	330	
	11	.045	W	WB	115	19.3	140	38.50" / 12:41	345	340	340	
	12	.045	W	WB	115	19.3	140	38.50" / 14:05	330	340	345	
	13											
	14											
	15	<u> </u>								ļ		
	16		1	l				1				

**BACKGRIND** 

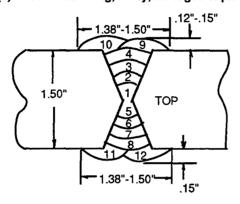
VFORM 1 REPORT NO: **WELD ARMOR DATA** SHEET SUBMITTED BY: GENERAL DYNAMICS PLATE NO: 108 DATE: **APRIL 8, 1994** LAND SYSTEMS DIVISION TYPE: 1161 BUCKEYE ROAD 3 THICKNESS: LIMA, OHIO 45804 1.50" SPECIFICATION: CONTRACT NO: DAAL04-91-C-0040 MIL-A-12560

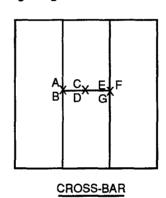
ORDNANCE MATERIAL CONCERNED: IMPROVED HARDNESS RHA

WELDED BY: ED JOHNSON

OBJECT: BALLISTIC SHOCK TEST

On a dimensional sketch of the groove and weldment, indicate: (1) the included angle; (2) the root opening; (3) the root face; (4) the bead sequence; (5) additional sketch of spacer strip on back-up, if any: (6) width of masking, if any, on edges of plate; (7) average height of reinforcement.





Weld reinforcement (has) (has not) been removed.

WELDING DATA

WELDING DATA											
NOZZI	LE COAT	ING: N	ONE			JOINT COATING: NONE					
PLATE	PREPAR	RATION:	GROUN	ND		BACKING	BACKING TAPE: CERAMIC				
POSIT	ION OF V	VELDING	VERT	CAL		SHIELDI	NG GAS: 95%	6 AR - 5%	OX		
WELDI	NG: G	MAW SE	MI-AUTC	MATIC .	- PULSE	DEW PC	INT: -86.1 F				
PREHE	EAT: 3	00 F				POSTHE	AT: NONE				
PEENI	NG: NO	ONE				BUTTER	ING: NONE				
PASS	ELEC	TYPE	CLEAN	AMPS	AMPS VOLT		WELD		ASS TEN	· · · · · · · · · · · · · · · · · · ·	
	SIZE	PASS				SPEED	LENGTH	A-B	C-D	E-F-G	
1	045	s	WB	135	19.8	230	8.50" / 1:18	310	310	310	
2	.045	W	WB	130	19.1	195	9,00" / 1:52	345	350	345	
3	.045	W	WB	140	19.8	195	10.00" / 2:50	305	310	305	
4	.045	W	WB	135	19.8	195	11.00" / 3:53	305	305	305	
5	.045	S	BG	130	19.8	200	9.00" / 1:37	310	315	310	
6	.045	W	WB	135	19.8	195	9.50" / 2:37	330	335	330	
7	.045	W	WB	140	19.6	195	9.75" / 2:30	320	330	320	
8	.045	W	WB	140	19.6	195	11.00" / 3:26	305	310	305	
9	.045	W	WB	110	19.3	140	11.75" / 4:10	330	330	330	
10	.045	W	WB	115	19.5	140	12.00" / 4:43	335	330	335	
11	.045	W	_WB	110	19.6	140	12.00" / 4:35	335	335	330	
12	.045	W	WB	110_	19.4	140	12.00" / 4:25	325	330	330	
13											
14				ROTAL	RY FILE AN	D GRIND ALL	STARTS AN	STOPS			
15											
16											

BACKGRIND

EOPH 2									C=-	ODT NO			
FURM 2	ARMOR PLATE DATA REPORT NO:  SHEET OF												
PLATE NO: 108				PLATE "A"					PLATE "B"				
	ACTURER:	<del>.   , ,</del>	S. STEE		<u> </u>			十				2	
TYPE:	10101.2				NESS R	LΙΛ		十					
THICKNE	SS:		50"	<u> J NAND</u>	NEOS FI	n <u>a</u>		十					<del></del>
HEAT NO			7840	<del></del>			······································	十					
LOT NO:		+	7040	<del></del>		·		+					
PROCES		+	.=	****			<del></del>	┽					<del></del>
PROOLS	· S.	<u> </u>	JENCH		MPERE EMICAL		POSITI			<del></del>			<del></del>
<u> </u>			_								T	<b>T</b>	1
	C	MN	SI	Р	s		R		NI	МО	ZR	<u> </u>	CU
TEST #1	.26	.40	.40	.012	.004	11	.47	3	3.21	.53	.03	.011	.02
TEST #2	<u> </u>											<u>.L.</u>	
HEAT TR	EATED BY	<u>':                                    </u>		HI	EAT TR	EATIN	G DAT	Α					
TABLE I					ELECT	RODE	DATA						
SIZE	MA	NUFAC	THOSE		TD	ADE NA	ME	$\neg$	i	TYPE		Ci	466
.045"			TURLE	$\rightarrow \uparrow$			(IVIE	$\dashv$		il- E-2376	5/0	CLASS Mil-100S-1	
.045	Lincoln E	lectric	····			- 100_		$\dashv$	191	II- E-2310	15/2	- IVIII- I	1005-1
	<del></del>			-				$\dashv$	<u> </u>				
				L			<u></u>		L				-,
TABLE II													
TRADE N	CTURER			CHEMICAL					. ANALYSIS				
AND SIZE				С	MN	SI	s		Р	CR	Ni	МО	СО
*****		CORE	WIDE	.0455				+,					
LA - 100 /	.045"			.0455	1.311	.2979	.0057	╫	0047	.0494	1.784	.4146	.0023
<del></del>			WELD METAL CORE WIRE		-			+					
			METAL					+					
-		CORE						+-					
l		WELD			$\vdash$			+					
TARLE	I (AUTON			G)	<u></u>			ــــــــــــــــــــــــــــــــــــــ		L			
	NUFACTU		<u>/</u>		ADE NA	MF			SIZ	7F	1	FLUX	
1417.43	101710101	12.1			, (DL 10)				SIZE			- I LUX	
·				· · · · · · · · · · · · · · · · · · ·					<del></del>		+		
DADIOOI	DADUEDE				<del></del>	· · · · · · · · · · · · · · · · · · ·				<del></del> -			
	RAPHED E												
	RAPH SER	IAL NO.	. R #20	53						· · · · · · · · · · · · · · · · · · ·	<del> </del>		
REMARK	S: The	procedu	re used	l in fabri	cating the	e crossb	ar weld	(is	s) <del>(is</del> -	net) the	same as	the	
					g the leg			-		•			
FARRICA <sup>*</sup>	TOR REP	RESENT	ΔTIVE				RESID	FNC	CE IN	SPECTO	R OF OR	DNANCI	= -
	FABRICATOR REPRESENTATIVE RESIDENCE INSPECTOR OF ORDNANCE												

FORM 3	(1) REPORT NO.
WELD RADIOGRAPHIC REPORT	SHEET NO OF
(2) X-RAY SERIAL NO: R #2053	
(3) PLATE SUBMITTED BY: GDLS (4) PLATE NO. HP #108	(5) SPEC. ASTM-E390 STD. II
(6) RADIOGRAPHED BY: GDLS (7) DATE	: 15 APRIL 1994
	TIME (12) FOCAL DIST. .6 - 2.0 MIN. 42"
(13) TYPE OF FILM KODAK 'M' (14) SCREENS OF	
SHOCK TEST PLATE	
SHOWING LOCATION OF RADIOGRAPHS AND RESULTS	OF TESTS
CHACK #### FUSION 1	INCOMPLETE PENETRATION
(16) RESULTS	:
1-2 SCATTERED POROSITY - STD I	!
3-4 SCATTERED POROSITY - STD I	!
5-6 SCATTERED POROSITY - STD I	
7-8 SOUND	
X-BAR SCATTERED POROSITY - STD I	
(17) NEGATIVES READ BY: In Secry (18) GOV'T Q. A. R	EP.

FORM 4

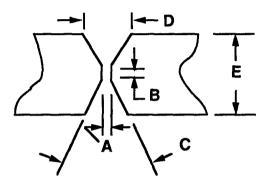
REPORT NO.

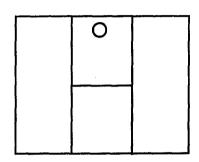
OF\_ SHEET \_\_\_

#### INSPECTION CHECK SHEET

H-PLATE NO. 108

CONTRACT NO. DAAL04-91-C-0040





- C) INCLUDED ANGLE 450
- D) BEVEL OPENING \_75" .81"
- E) PLATE THICKNESS \_\_\_ 1.50"

RIGHT LEG FIT-UP LEFT LEG FIT-UP **CROSS-BAR FIT-UP** 

**DISCREPENCIES AND/OR DEVIATIONS** 



# DEPARTMENT OF THE ARMY U.S. ARMY COMBAT SYSTEMS TEST ACTIVITY ABERDEEN PROVING GROUND, MARYLAND 21005-5059



REPLY TO ATTENTION OF

Advanced Armor Division

Date: June 21, 1994

Manufacturer : General Dynamics address : 1161 Buckeye Road

Lima, Ohio 45804

POC : Mark Niese

A ballistic weld test on the following material was conducted by the U.S. Army Combat Systems Test Activity. The results are as follows:

Firing Record No.: 940672

Plate No.: 108

Contract No: DAAL04-91-C00040

Shot No.	Type of Material	Actual Thickness	Projectile	Req Vel (fps)	Act Vel (fps)	Total Weld Cracking (in)	pass fail
1	RHA	1.491	75-mm M1002	1194	1204	1-1/2"	Pass
2	RHA	1.491	75-mm M1002	1194	1206	9-1/2"	Pass

Sample no. 108 passed the ballistic requirements of MIL-STD-1946A. The sample sustained 1-1/2" zone cracking on the impact side and no cracking on the opposite side of impact No 1. Impact No 2 sustained a 2-3/4" zone cracking on the impact side and 6-3/4" weld cracking on the opposite side of impact 2.

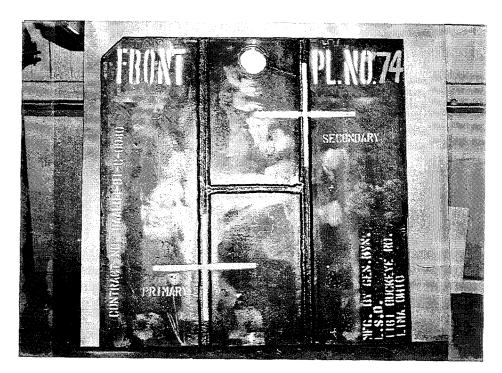
If you have any questions concerning these test results, please contact Mr. Richard Latham, phone (410)-278-7966.

JAMES P. FINFERA

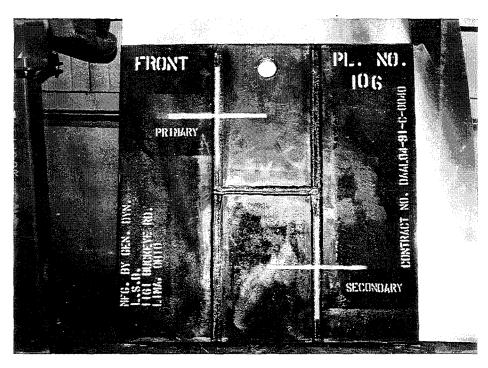
Thiband E. Salham

Chief, Advanced Projects Division

#### **ATTACHMENT 8 - H-PLATE DATA SHEET**

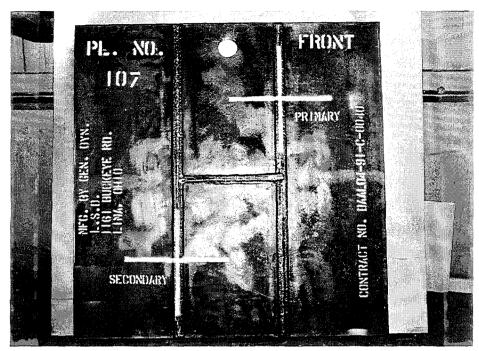


BASE METAL H-PLATE NO. WELD PROCESS RHA
74
HIGH CURRENT DENSITY



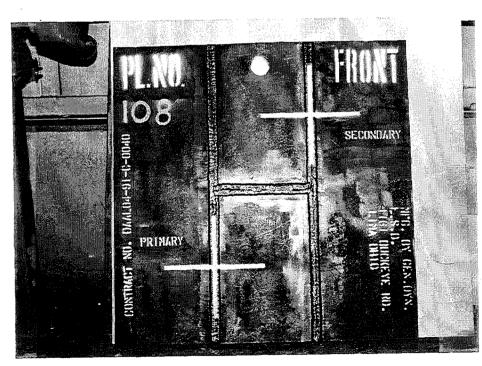
BASE METAL H-PLATE NO. WELD PROCESS IMPROVED HARDNESS RHA
106
HIGH CURRENT DENSITY

### ATTACHMENT 8 - H-PLATE DATA SHEET



BASE METAL H-PLATE NO. WELD PROCESS

IMPROVED HARDNESS RHA 107 GMAW - SPRAY

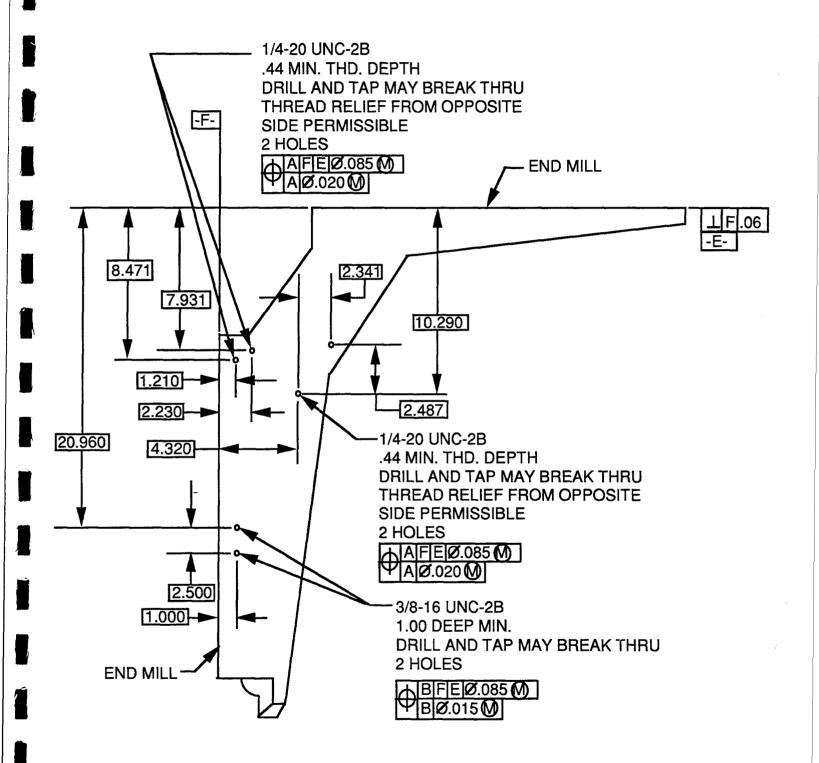


BASE METAL H-PLATE NO. WELD PROCESS

IMPROVED HARDNESS RHA
108
GMAW - SPRAY (PULSE)

**ATTACHMENT 9 MACHINABILITY DATA SHEETS** GENERAL DYNAMICS
LAND SYSTEMS DIVISION

### IMPROVED RHA MACHINABILITY DATA SHEET P/N - 9377636 - 1 MD PLATE CONFIGURATION



AMMO DOOR SUPPORT PLATE

### **G.D.L.S. I-RHA MACHINABILITY DATA SHEET**

MATERIAL TYPE	IMPROVED HARDNESS RHA					
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)					
TOOL DESCRIPTION	SPOT DRILL					
MANUFACTURER	CLEVELAND TWIST DRILL					
OPERATION DESCRIPTION	SPOT DRILL 6 PLACES/PLATE					
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  0.50						
OBSERVATIONS:	ERATION PERFORMED SATISFACTORY.					
	WEAR OR HEAT BUILD-UP WAS NOTED					
DURING THE OPERATION.						
CONCLUSIONS: THE SPOT DRILL	OPERATION CAN BE PERFORMED USING					
THE EXISTING TOOLING USED ON THE RHA MATERIAL.						

### **G.D.L.S. I-RHA MACHINABILITY DATA SHEET**

MATERIAL TYPE IMPROVED HARDNESS RHA					
PART NO. MACHINED 9377636 - 1 MD (6 PLATES)					
TOOL DESCRIPTION 1/4 - 20 UNC TAP					
MANUFACTURER					
OPERATION DESCRIPTION TAP 4 HOLES/PLATE - 2 FLUTE PLUG					
TIME IN CUT (MIN)					
OBSERVATIONS:  NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED  DURING THE TAPPING OPERATION. THE TAPPED HOLES WERE  TESTED WITH A THREAD GAGE AND WERE ACCEPTED.					
CONCLUSIONS:					
THE 1/4 - 20 UNC TAPPING CAN BE PERFORMED SATISFACTORY					
WITH THE CURRENT TOOLING. TOOLING LIFE MAY BE SHORTENED					
DUE TO THE INCREASED HARDNESS.					

### **G.D.L.S. I-RHA MACHINABILITY DATA SHEET**

MATERIAL TYPE	IMPROVED HARDNESS RHA				
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)				
TOOL DESCRIPTION	9/32" DRILL				
MANUFACTURER	CLEVELAND TWIST DRILL				
OPERATION DESCRIPTION	DRILL - 4 HOLES/PLATE				
TIME IN CUT (MIN)  HP  SFM  RPM 450  DIA 9/32"	COOLANT CL IPM1.4 TEETH				
OBSERVATIONS:  THE DRILL STARTED 'DULLING' ON THE THIRD HOLE OF EACH PLATE EXHIBITING EXCESSIVE WEAR ON THE DRILL. THE DRILL					
WAS BACKED O	FF AND REPLACED. A TOTAL OF THREE DRILLS				
WERE USED TO COMPLETE THE OPERATION.					
CONCLUSIONS:					
A DIFFERENT ALLO	Y DRILL BIT WOULD NEED TO BE USED. THE				
FEED RATES AND S	SPEED COULD ALSO BE MODIFIED, BUT FURTHER				
TESTING WOULD BE REQUIRED.					

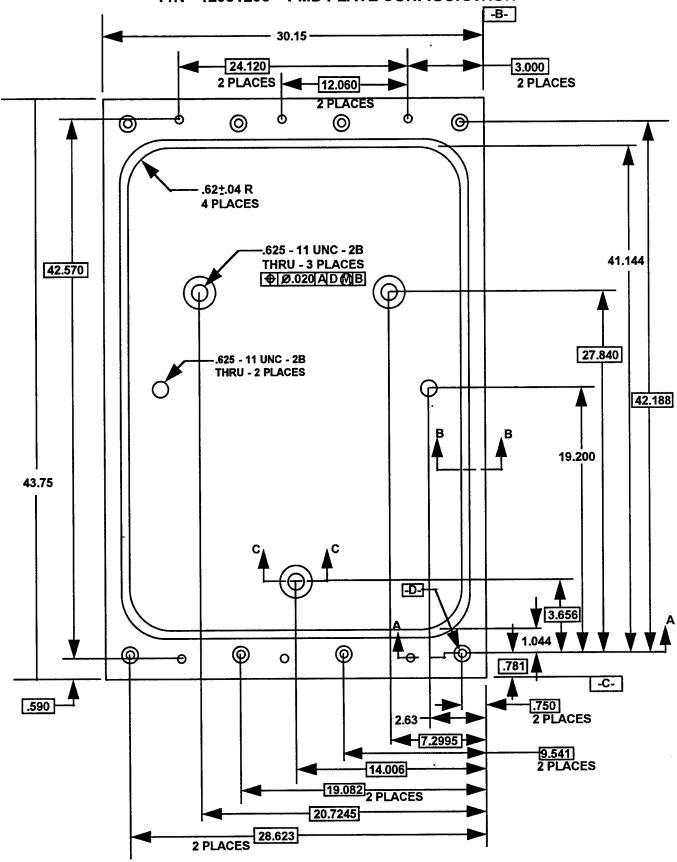
MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)
TOOL DESCRIPTION	DRILL
MANUFACTURER	CLEVELAND TWIST DRILL
OPERATION DESCRIPTION	DRILLING - 4 HOLES/PLATE
TIME IN CUT (MIN)  HP  SFM  RPM 470  DIA .201"	COOLANT CL IPM 1.5 TEETH
OBSERVATIONS:  THE DRILLING OPE	RATION PERFORMED SATISFACTORY
WITH NO EXCESSI\	/E TOOL WEAR OR HEAT BUILD-UP NOTED DURING
THE OPERATION.	THE TOOL LIFE MAY BE SHORTENED DUE TO
THE INCREASED HA	ARDNESS.
CONCLUSIONS:	
THE DRILLING OPERA	ATION CAN BE PERFORMED WITH THE CURRENT
TOOLING SUPPLIED A	AT LATP WITH THE GIVEN FEED AND TRAVEL RATES.
A DIFFERENT TOOL A	ALLOY MAY INCREASE THE TOOL LIFE.

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)
TOOL DESCRIPTION	3/8 - 16UNC TAP
MANUFACTURER	
OPERATION DESCRIPTION	TAP 2 HOLES/PLATE
TIME IN CUT (MIN)  HP  SFM  RPM  200  DIA  3/8'	<del>''''                                 </del>
OBSERVATIONS:  NO EXCESSIVE TO	OL WEAR OR HEAT BUILD-UP WAS NOTED
DURING THE TAPPI	ING OPERATION. THE TAPPED HOLES WERE
TESTED WITH A THREAD GAGE AND WERE ACCEPTED.	
1	
CONCLUSIONS:	
THE 3/8 - 16 UNC TA	APPING CAN BE PERFORMED SATISFACTORY
WITH THE CURREN	T TOOLING. TOOL LIFE MAY BE SHORTENED DUE
TO THE INCREASED	HARDNESS.

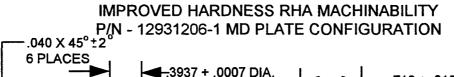
MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)	
TOOL DESCRIPTION	DRILLING	
MANUFACTURER	CLEVELAND TWIST DRILL	
OPERATION DESCRIPTION	DRILL (2 HOLES/PLATE)	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  5/16		
OBSERVATIONS:		
THE DRILLING OPERATION PERFORMED SATISFACTORY.		
NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS NOTED		
DURING THE OPERATION.		
CONCLUSIONS:		
THE 5/16" DRILLING O	PERATION CAN BE PERFORMED WITH THE	
CURRENT TOOLING U	ISED ON THE RHA MATERIAL.	

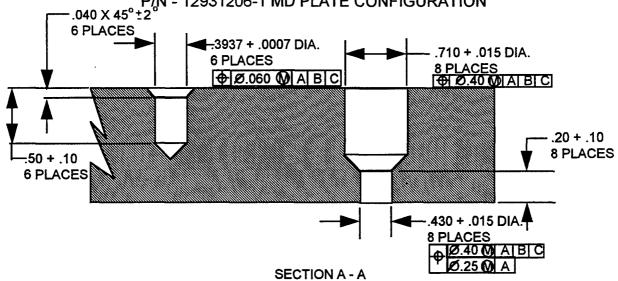
MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	9377636 - 1 MD (6 PLATES)
TOOL DESCRIPTION	3.935" MILL
MANUFACTURER	SECO
OPERATION DESCRIPTION	EDGE MILL - 2 EDGES/PLATE
TIME IN CUT (MIN)  HP  SFM  RPM 500  DIA 3.93	
OBSERVATIONS:	
THE EDGE MILL (	OPERATION PERFORMED SATISFACTORY.
NO EXCESSIVE 1	TOOL WEAR WAS NOTED AFTER THE MACHINING
OPERATION.	
	OPERATION CAN BE PERFORMED USING
THE EXISTING IC	JOLING ON THE RHA WATERIAL.

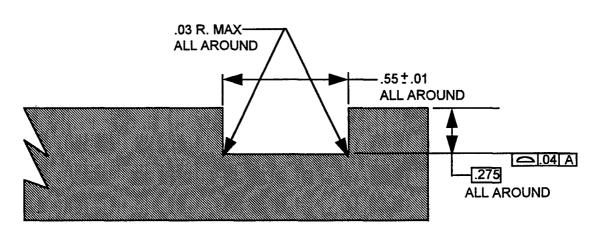
# IMPROVED HARDNESS RHA MACHINABILITY DATA SHEET P/N - 12931206 - 1 MD PLATE CONFIGURATION



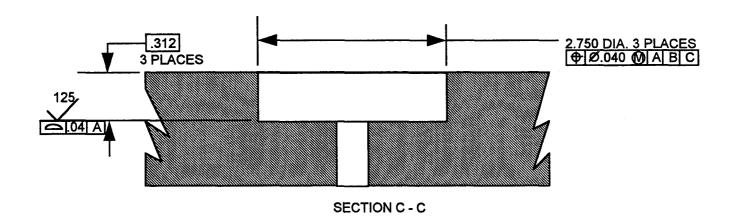
**BLOW-OFF PANEL** 







SECTION B - B



**BLOW-OFF PANEL** 

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	1.00" DIA. TURBO MILL
MANUFACTURER	CARBOLOY
OPERATION DESCRIPTION	MILLING OF AMMO RACK HOLES
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  1.00"	COOLANT CL IPM 10.0 TEETH
OBSERVATIONS:	
THE MILLING OPERA	TION PERFORMED SATISFACTORY. NO
EXCESSIVE TOOL W	EAR OR HEAT BUILD-UP WAS NOTED DURING
THE OPERATION.	
CONCLUSIONS:	
	TION CAN BE PERFORMED WITH THE
CURRENT TOOLING U	ISED ON THE RHA MATERIAL.

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	2.50" DIA. CENTRE-DEX MILL	
MANUFACTURER	WELODON	
OPERATION DESCRIPTION	MILL 3 HOLES/PLATE	
TIME IN CUT (MIN)  HP  SFM  RPM  70  DIA  2.50"	COOLANT CL IPM0.4 TEETH	
OBSERVATIONS:		
THE MILLING OF THE	E AMMO RACK HOLES PERFORMED	
SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP		
WAS NOTED DURING THE MILLING OPERATION.		
CONCLUSIONS:		
THE MILLING OF TH	E AMMO RACK HOLES COULD BE PERFORMED	
WITH THE CURREN	T TOOLING USED ON THE RHA MATERIAL.	

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	5/8 - 11 UNC SPIRAL POINT TAP	
MANUFACTURER	HANSON WHITNEY	
OPERATION DESCRIPTION	TAP 5 5/8 - 11UNC HOLES	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  5/8"	COOLANT CL IPM TEETH	
	ATION FOR THE LIFTING LUGS AND AMMO	
TOOL WEAR OR HEAT BUILD-UP WAS NOTED DURING THE		
OPERATION.		
CONCLUSIONS:		
THE TAPPING OPERA	ATION FOR THE 5/8 - 11 UNC HOLES COULD	
BE PERFORMED USI	NG THE CURRENT TOOLING USED ON THE	
RHA MATERIAL.		

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	17/32" DIA. STRAIGHT SHAFT DRILL	
MANUFACTURER	NATIONAL TWIST DRILL	
OPERATION DESCRIPTION	DRILL - 5 HOLES/PLATE	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  17/3		
OBSERVATIONS:		
THE LIFTING LUG A	ND AMMO RACK HOLES WERE DRILLED	
SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP		
WAS NOTED DURING THE DRILLING OPERATION.		
CONCLUSIONS:		
THE DRILLING OPERAT	ION FOR THE LIFTING LUGS AND AMMO RACK	
HOLES COULD BE PER	FORMED WITH CURRENT TOOLING USED ON	
THE RHA MATERIAL.		

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION 1	0 MM DIA. STRAIGHT SHAFT REAMER	
MANUFACTURER	NATIONAL TWIST DRILL	
OPERATION DESCRIPTION	REST BUTTON REAMING	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  10 MM	COOLANT CL IPM1.4 TEETH	
OBSERVATIONS:		
THE REST BUTTON HO	DLE REAMING OPERATION PERFORMED	
SATISFACTORY. NO E	EXCESSIVE TOOL WEAR OR HEAT BUILD-UP	
WAS NOTED DURING THE OPERATION.		
CONCLUSIONS:		
THE REST BUTTON REA	MING OPERATION COULD BE PERFORMED	
WITH THE CURRENT TO	OLING USED ON THE RHA MATERIAL.	

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	3/8" DIA. STRAIGHT SHAFT DRILL	
MANUFACTURER	CLEVELAND TWIST DRILL	
OPERATION DESCRIPTION	DRILLING OF REST BUTTON HOLES	
TIME IN CUT (MIN)  HP  SFM  RPM 450  DIA 3/8"	COOLANT CL IPM 1.3 TEETH	
OBSERVATIONS:  THE DRILLING OPERATION PERFORMED SATISFACTORY WITH  NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP NOTED DURING  THE OPERATION.		
CONCLUSIONS:		
THE DRILLING OPERAT	TION COULD BE PERFORMED WITH THE CURRENT	
TOOLING USED ON TH	E CURRENT RHA MATERIAL.	

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	7/16" DIA. STRAIGHT SHAFT DRILL	
MANUFACTURER	PRECISION TWIST DRILL	
OPERATION DESCRIPTION	DRILLING - 8 HOLES/PLATE	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  7/16"		
OBSERVATIONS:		
THE DRILLING OPERAT	TION FOR THE HOLD DOWN HOLES PERFORMED	
SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS		
NOTED DURING THE OPERATION.		
CONCLUSIONS:		
THE HOLD DOWN HOLES COULD BE MACHINED WITH THE CURRENT		
TOOLING USED ON THE RHA MATERIAL.		

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	23/32" DIA., #2 MT DRILL	
MANUFACTURER	PRECISION TWIST DRILL	
OPERATION DESCRIPTION	DRILLING - 8 HOLES/PLATE	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  23/32		
	TION FOR THE HOLD DOWN HOLES PERFORMED	
SATISFACTORY. NO EXCESSIVE TOOL WEAR OR HEAT BUILD-UP WAS		
NOTED DURING THE DRILLING OPERATION.		
CONCLUSIONS:		
THE DRILLING OF THE	HOLD DOWN HOLES COULD BE PERFORMED	
WITH THE CURRENT I	OOLING USED ON THE RHA MATERIAL.	

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	1/2" DIA. STRAIGHT SHAFT DRILL	
MANUFACTURER	PRECISION TWIST DRILL	
OPERATION DESCRIPTION	SPOT DRILL - 6 HOLES/PLATE	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  1/2"	COOLANT CL IPM2.5 TEETH	
OBSERVATIONS:		
THE SPOT DRILLING C	PERATION PERFORMED SATISFACTORY.	
NO EXCESSIVE TOOL	WEAR OR HEAT BUILD-UP WAS NOTED	
DURING THE OPERATION.		
	PERATION COULD BE PERFORMED WITH THE	
CURRENT TOOLING USED ON THE RHA MATERIAL.		

PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION .5	58" DIA., 4 FLUTE DOUBLE END MILL	
MANUFACTURER	PRECISION TWIST DRILL	
OPERATION DESCRIPTION _	SEAL GROOVE MILLING	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  .558"	COOLANT	
OBSERVATIONS:  THE SEAL GROOVE MILLING OPERATION PERFORMED SATISFACTORY  WITH NO EXCESSIVE WEAR OR HEAT BUILD-UP NOTED DURING THE  MILLING OPERATION.		
	PERATION COULD BE PERFORMED WITH	

MATERIAL TYPE	IMPROVED HARDNESS RHA	
PART NO. MACHINED	12931206 - 1MD (3 PLATES)	
TOOL DESCRIPTION	2-FLUTE HSS END MILL	
MANUFACTURER	WELODON	
OPERATION DESCRIPTION	MILLING OF SEAL GROOVE	
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  1/2"	COOLANT CL IPM2.8 TEETH	
OBSERVATIONS:		
THE MILLING OPERATION	ON FOR THE SEAL GROOVE PERFORMED	
SATISFACTORY. NO EX	XCESSIVE TOOL WEAR OR HEAT BUILD-UP	
WAS NOTED DURING T	HE OPERATION.	
CONCLUSIONS:		
THE MILLING OPERATION COULD BE PERFORMED WITH THE		
CURRENT TOOLING USED ON THE RHA MATERIAL.		

MATERIAL TYPE	IMPROVED HARDNESS RHA
PART NO. MACHINED	12931206 - 1MD (3 PLATES)
TOOL DESCRIPTION	FACE MILL
MANUFACTURER	CARBOLOY
OPERATION DESCRIPTION	FACE MILL PANEL SURFACE
TIME IN CUT (MIN)  HP  SFM  RPM  DIA  12.5"	COOLANT CL IPM TEETH 10 CARBOLOY SEKN-42 INSERTS

#### **OBSERVATIONS:**

THE FACE MILL CUTTING PERFORMED SATISFACTORY. THE CUTTING

EDGES OF THE INSERTS DID NOT SEEM TO WEAR EXCESSIVELY, ALTHOUGH

THE FACE OF THE INSERTS EXHIBITED NOTABLE SIZE CHIPS REMOVED. THE

SIZE OF THE CHIPS WERE APPROX. 38" DIAMETER. IT IS BELIEVED THE HARD

SCALE ON THE SURFACE OF THE PLATE WAS THE CAUSE FOR THE CHIPS.

THE PLATE SURFACE REMAINED RELATIVELY FLAT AFTER THE FACE MILL

OPERATION, WHICH SHOWS GOOD STRESS RELIEF CHARACTERISTICS.

#### **CONCLUSIONS:**

THE FACE MILL OPERATION COULD BE PERFORMED USING THE EXISTING

TOOLING, BUT ALTERNATIVE INSERTS SHOULD BE EVALUATED.